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NOTICE.

ANNAPOLIS, MD., *February* 14, 1894.

Having carefully read the three essays submitted in competition for the prize offered by the U. S. Naval Institute for the year 1894, we have the honor to announce that, in accordance with Article XI. of the Constitution, the prize is awarded to the essay bearing the motto "Cry Havoc, and let slip the dogs of war," on the U. S. S. Vesuvius, with Special Reference to her Pneumatic Battery, by Lieut.-Comdr. Seaton Schroeder, U. S. N.

Honorable mention is accorded to the essay bearing the motto "If a house be divided against itself that house cannot stand," on Naval Reform, by P.-Asst. Eng. F. M. Bennett, U. S. N.

B. F. TILLEY,
Lieutenant-Commander, U. S. Navy.
R. R. INGERSOLL,
Lieutenant-Commander, U. S. Navy.
G. L. DYER,
Lieutenant, U. S. Navy.
H. OSTERHAUS,
Lieutenant, U. S. Navy.
W. F. WORTHINGTON.
P. Asst. Engineer, U. S. Navy.
N. M. TERRY,
Professor, U. S. Naval Academy.
J. H. GLENNON,
Lieutenant, U. S. Navy.
Members, Board of Control.

NOTICE.

It is earnestly desired that all manuscript of discussions on any articles in this number be forwarded to the Secretary and Treasurer not later than September 15, 1894.

By direction of the Board of Control,
J. H. GLENNON, *Lieutenant, U. S. Navy,*
Secretary and Treasurer.

ERRATA.

Page 2, second line, "Paixyan" should be "*Paixhan.*"
Page 5, thirteenth line, "20-inch gun" should be "*XX-inch gun.*"
Page 6, ninth line from bottom, "most" should be "*almost.*"
Page 8, second line from bottom, "low" should be "*slow.*"
Page 11, sixteenth line, "effect" should be "*affect.*"
Page 14, fifth line, "effecting" should be "*affecting.*"
Page 15, first line, "requirement" should be "*requirements.*"
Page 15, fourth line, "9-inch gun" should be "*IX-inch gun.*"
Page 16, eleventh line, after "hit" write "*upon.*"
Page 20, fourteenth line, take out "of" before "the diagonal."
Page 29, seventh line from bottom, "time" should be "*times.*"
Page 30, first line, "of" (after "functions") should be "*for.*"
Page 30, last equation, $\frac{A_u - A_v}{S_u - S_v} - S_v$ should be $\frac{A_u - A_v}{S_u - S_v} - I_v$.
Page 48, twentieth line, after "eminent" write "*a.*"


Hart. N.Y.
U.S. Dynamite Cruiser Vesuvius,

THE PROCEEDINGS

OF THE

UNITED STATES NAVAL INSTITUTE.

Vol. XX., No. 1. **1894.** **Whole No. 69.**

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

PRIZE ESSAY, 1894.

"Cry 'Havoc,' and let slip the dogs of war."—*Julius Cæsar*, Act iii. Sc. i.

THE U. S. S. VESUVIUS,

WITH SPECIAL REFERENCE TO HER PNEUMATIC BATTERY.

By Lieut.-Comdr. Seaton Schroeder, U. S. N.

The first Naval Board on the pneumatic gun reported it as "a new instrument of warfare, which has its own functions in time of war. It cannot replace any existing weapon, nor can its place be wholly taken by any other."

That is a good text to keep in mind.

There is a natural tendency among inventors, or perhaps rather among their injudicious friends and financial backers, to attach an undue importance to their productions; and sometimes claims are made, or are supposed to be made, which cloud the understanding of non-professional men, and tend to create an unfavorable bias in the minds of those who are called upon to pass professional judgment.

Since the introduction of steam power, revolutions in naval warfare have not been lightly recognized. General Paixyan's invention bore terrible fruit in the destruction of the Turkish fleet at Sinope, and it was then thought that the use of explosive shell had rendered the immediate abandonment of wooden hulls inevitable; but that change came so gradually that it would be difficult to trace the connection, and the most important consequence of the battle was the influence it had in hastening the application of armor (on wooden hulls) in France five years later. The appearance of the automobile torpedo, a quarter of a century ago, in turn made a profound stir among naval tacticians; but, in spite of enthusiastic predictions to the contrary, the battleship has survived as the great leading factor in naval supremacy.

It is much the same in considering the uses to which we have learned to put electricity, or the great volume of fire obtainable with R. F. guns, or the great velocities and the smokelessness of recent powders, or the wonderful advances made in marine propulsion. Sometimes a development like the application of armor, or an invention like the torpedo, will go so far as to lead to the production of a new type of vessel; and the aggregation of new features has in the course of recent years so far modified the means and conditions of battle as to make the saying quite true that in the past third of a century, naval warfare has been revolutionized. But, as a rule, single new weapons at most have an influence in imposing modifications in the structural and other defensive features of existing types of vessels, and possibly in the composition and tactics of existing fleets. Nothing, apparently, can displace nor replace the battleship; but her means of offense and defense are liable to change, and a protection up to date will comprise not only continual improvement in her own inherent resisting qualities, but a great expansion of the system of counter-torpedo-boats called into existence by the exigencies of torpedo attack and defense. The number and the power of these "hunters" are bound to be increased if the pneumatic gun can so extend the range and destructiveness of the torpedo as to strike from a mile distance with greater accuracy and with heavier charges than can now be done from a quarter of a mile.

In these last remarks the value of the pneumatic gun has been seemingly contrasted with that of the automobile torpedo; and to

many officers such a comparison appears to be the only one which should be allowed to stand. Many have raised their voices in deprecation of the name "gun." Some even have gone so far as to condemn the whole business because of its bearing that cherished name, acknowledging afterwards, when the expression "aerial torpedo projector" was deftly introduced, that under the changed conditions of nomenclature they might lend a kindlier ear to statements of its military usefulness.

It may not be amiss to suggest that the subject even of the name has a certain importance, and that it is to be regarded from two standpoints—that of its mode of action, and that of its effect. The operation resembles that of a gun, while in the matter of its effect it more closely approaches the torpedo.

In guns the projectile is thrown from a tube by the pressure of a highly expansive gas more or less quickly generated and applied; it matters little whether the application of this gas is produced by the combustion of a mechanical mixture like black powder, or of a chemical compound such as some of the smokeless powders, or by the sudden liberation of compressed air or steam, or by an explosive mixture of air and volatile hydro-carbons; the power varies in degree, but in all cases the path of the projectile is in a more or less curved trajectory, and the laws that govern the exterior ballistics are the same as apply to all bodies moving in air.

With the development of their present high power, guns are apt to be regarded solely as weapons for piercing or battering in heavy armor. That is not correct. Many close observers agree that future naval battles will be won not by heavy armor-piercing shell, but by the hail of smaller fire from the auxiliary and secondary batteries, and by the destruction caused by the explosion of the heavier charges contained in the common shell which cannot pierce armor. As was pointed out and cleverly commented upon by Admiral Colomb, R. N., in a recent number of the *North American Review*, there is no adequate target offered to the enormous guns which form the main batteries of battleships of the present fashion. Indeed it seems not improbable that if the plan of concentrating all the armor around a few most important parts of a ship had continued to expand, there might have been a partial reaction toward guns of larger bore and lower power firing shell of greater mine power; and it seems reasonable to expect now that, in a fight

between unarmored vessels, the one carrying a certain weight of light, large-bore, low-power guns would quickly crush the one armed with an equal weight of heavy, high-power B. L. R's. The comparatively recent recession from the once prevalent idea of a few very heavy guns, in a small vessel, to a larger number of lighter ones was a step in this direction, and it seemed possible that increase of bore and reduction of power would eventually follow. In fact, a few years ago general designs of short, light 9-inch B. L. R's, weighing about five tons, were gotten up in the belief that they might be of value in other than unarmored vessels; but by an apparent retrogression to the principles of thirty years before, the designers of the Dupuy De Lôme had recognized the necessity of keeping out the detonating shell, just as in 1858, the man after whom that vessel was named had kept out the exploding shell, and the value of thin armor was once more brought to the front. It was then reasoned that to get through four inches of steel would require that both gun and projectile should be much stronger and heavier, and the very object in view would be defeated. For use against battleships, therefore, such a gun would seem less formidable now, unless all idea of penetration be given up and a light shell be used carrying a charge so heavy as to be formidable from its disruptive effect even if outside the vessel.

It may be observed in passing that this thin armor, originally adopted to keep out high explosives, incidentally affords protection from secondary battery fire, and for that reason will the more surely remain in favor in armored vessels, and continue to influence the problem of detonating shell fire.

Now as regards the *effect*, as bearing upon the name to be given the aerial torpedo projector: When the projectile strikes a few yards short of the enemy (as should always be the aim), and explodes in contact with his under-water body, it produces the so-called "torpedo effect," and it might therefore be considered a torpedo. But if it strikes above water it is not called a torpedo effect, any more than if a shell from a powder gun should burst in the upper works. In the general design of a ram recently proposed by the late Chief of the Bureau of Ordnance, details of which have not been published, the armament includes four 9-inch short-bore rifled mortars, to throw 200-lb. charges of some high explosive; that officer would probably be surprised to hear those weapons classed

as torpedoes; and yet they resemble the pneumatic gun in that they must have a more or less curved fire, and are designed to throw an amount of explosive which would certainly produce a torpedo effect if detonated under water.

While, then, one of the objects sought, and the most important one, is to produce an effect now attributed to the torpedo alone, the manipulation, ballistics and general mode of action as affected by physical conditions are distinctively those of a gun. The term mortar has been sometimes applied, possibly with a tinge of implied reproach, as suggestive of the conditions which tend to make successful mortar firing from a vessel so problematic. A few years ago I happened to witness some target practice with a 20-inch gun, and noticed that the elevation was 16 degrees; but no one thought of calling that a mortar. Sixteen degrees is the exact angle that was selected for the guns of the Vesuvius; it was afterwards increased to 18 degrees to obtain an angle of fall which would insure non-ricochet. Correctly speaking, this may be termed howitzer fire, but it is certainly not mortar firing. The name "pneumatic *gun*" therefore seems eminently applicable and proper. A name is not all-important, but it is a good thing to have; and it clears the atmosphere when a misleading term leaves an erroneous impression concerning both functions and value.

The first line of defense of a country is the naval line of battle. Some of the guns that are to protect our harbors must be mounted at sea and meet the enemy there. It therefore does not seem unnatural that when a new one made its appearance the idea should have suggested itself to try it afloat. The conception may have been hastened by the hostility manifested by many eminent military men who were mostly preoccupied with the development of mines and torpedoes and correlative defensive works; the great objection raised to its installation on shore is, as voiced by General Abbott, that ". . . (on account of its limited range) . . . we could hardly fail to damage our mines, and thus perform for the enemy work which it is the part of wisdom to force him to undertake himself." The validity of this objection may be open to question; but it does not enter into a discussion of the Vesuvius, excepting in so far as it emphasizes her value as a counterminer.

The accuracy of the pneumatic gun being seriously doubted even when mounted on a steady platform, it is not to be wondered

at that the difficulties attending its successful employment were generally thought to be greatly enhanced by installation on an unsteady platform. Certain it is that the conception of a sea-going vessel to carry guns capable of only curved fire raised a storm in the naval professional breast; and partly, it is said, to allay opposition from that quarter, it was proposed that the vessel should have great speed so as to be available for other purposes if desired. The influence of naval circles in opposing or promoting the idea was possibly not great; but the Silliman was blown up, and the Report of the Board was favorable, and the construction of the Vesuvius was authorized.

So far as is now known she was the first vessel ever built to carry pneumatic guns, and the prime object in building her was to thoroughly test the system with a view to building others if her performance were such as to warrant it. It therefore seemed all the more to be deplored that, from causes which do not come within the scope of a professional paper, two years and a half elapsed after her commissioning before she was subjected to a serious trial. During that time, fortunately, improvement was effected in the mechanism for regulating the range. It is perhaps safe to say that had the Vesuvius been put to a thorough test immediately after passing the acceptance trial, satisfactory results could not have been achieved, and the system would have been completely "snowed under." But in these days the solution of a plain mechanical problem is only a question of a short time as a rule, and within a few months after the acceptance of the vessel a new range valve had been produced and tried on other guns with a success that was surprising. This mere fact should accentuate the expectation of still further improvement in that, as in all things. Look at the Howell torpedo; some years ago it was inevitably rejected by a naval board; to-day it does most everything except talk,—and it may be even said to do that in the sign language. Yet a considerable further advance is actually in sight there still. Take also the case of the Sims-Edison controllable torpedo; when adopted in principle by the Army a few years ago, its speed was nine miles an hour; it is now equal to that of the Patrick, say nineteen or twenty.

A discussion of the value of the pneumatic gun afloat is apt to become a discussion of the Vesuvius as a unit; that is, of the com-

bination of hull, engines and battery as effected in her. But that is not consequential. The individual ship was designed simply to carry the guns and to satisfy the popular and somewhat erratic cry for great speed; and the latter object was attained at a sacrifice of other features. The question at issue is whether or not a pneumatic gun, throwing large quantities of high explosive a mile or more, may be made to serve a useful purpose afloat. If it can, a vessel will be designed to remedy defects which exist in this first model. When the Gabriel Charmes was condemned as a gunboat, it did not seal the doom of the B. L. R., but only of the absurd type of vessel in which it was mounted.

The use of air as a propelling agent possesses merit in the qualities of starting the projectiles from a state of rest with a comparatively moderate shock, and of doing so not only without a dangerous increase of temperature, but with actually a fall due to the expansion of the air. The former quality is important because of the liability of high explosives to be detonated by a great shock, and also and mainly because of the saving that may be effected in the strength and weight of the containing shell, and the corresponding increase in the weight of the charge. That is to say, from this mechanical standpoint the problem which has been solved is that of throwing detonants in large quantities.

Apart from the normal gentleness of impulse, there is one other tangible element of safety worthy of consideration in the use of air for firing shell containing detonants, and that is that the pressure is always known and constant. With powder this is not always the case. A few years ago, an accepted motto, dating from the time of Cromwell, was still to "Put your trust in God, my boys, and keep your powder dry;" at present, if you let the powder get dry you will injure and possibly burst the gun. We not infrequently hear of this happening with modern ordnance, and the only consolation is that the subsequent investigating board generally determines what was the matter and we try to guard against a recurrence from the same cause. With B. L. R's it cannot result from double shotting as has been suspected in the past with muzzle-loaders; but it may still follow from the powder losing its moisture or being otherwise deteriorated through age; or it may have become heated or dried in a magazine possibly located amidships between two boiler rooms (as in one of our new

vessels). Instances have even been known of a very violent recoil, indicating an abnormal pressure, resulting when the metallic cartridge has been placed and left for a while in a R. F. gun heated by previous firing. In a great majority of cases these erratic stresses will not effect the integrity of the gun, but they might easily disrupt a light shell of large capacity; and such eventualities have to be considered in the design of detonating shell. In the air gun the bore might be completely choked and the entire contents of the reservoir turned on, but the pressure could not exceed the 1000 pounds which had been pumped up.

Gun-cotton can undoubtedly be thrown from powder guns, especially mortars; but this has not yet been done on any useful scale, and there are certain great inconveniences attending its employment which interfere with its adoption for bursting charges. Also, projectiles which are intended to pierce armor with the hope of exploding inside, carry a burster amounting to only two to four per cent. of the total weight thrown; the common shell ordinarily carries considerably more than the A. P., but it is ineffective against light armor, and the percentage carried does not usually exceed ten. The full-calibre projectile of the 15-inch pneumatic gun, weighing 950 to 1000 pounds, carries 500 pounds gelatine, or over one-half of the total weight. The reason for this is that in the powder gun a pressure of 15 tons per square inch (possibly much increased in the way just mentioned) is applied almost instantly, and a great and and sudden rotary velocity is also imparted; while in the air gun a pressure of 750 or 1000 pounds is generally used, and there is no rotary motion except a very gentle one gradually imparted during flight by the pressure of the atmosphere on the diagonal vanes. If the air reservoirs and gun were made stronger, and the pressure increased, the projectiles would have to be stronger and heavier; on the other hand, if the powder charge be reduced, or made extremely slow in its action, the shell could be made lighter and lighter until matters would be about the same as in the air gun. Steps in this direction are apparently in contemplation, and it is possible that the extremely low velocity required for a light shell may be obtained with powder or some similar composition. But apart from the difficulties of securing homogeneity of action in such low compositions and of guarding against the heat of discharge, serious mechanical difficul-

ties would be encountered; to obtain the same velocity without increase of maximum strain or shock would require the same travel and, therefore, the same length of gun. Now, one great advantage of compressed air lies in the ability to vary the range quickly at will by varying the I. V.; in the powder gun the range must be varied by changing the elevation, and to materially change the elevation of a 44-calibre 15-inch gun would be a serious problem in a small, light vessel, especially if coupled with train.

It is also claimed by the champions of the pneumatic system that a greater accuracy can be attained by it than with powder guns firing light charges and dependent upon change of elevation for change of range; and at about the time that pneumatic guns were beginning to attract attention, it happened that some mortar firing in Roumania, which was less successful than had been expected, appeared to bear out the claim. This will be touched upon later.

The grave disadvantage of a low velocity is that the curved trajectory requires a more or less accurate knowledge of the range, and absolutely limits its employment to cases where the range can be ascertained. With regard to this, a moderate error is counterbalanced to a certain extent by the fact that the size of the effective target is much greater than with any other weapon. The torpedo strikes under water; the armor-piercing shell attacks the armored portion of the hull above water; but with the shell from the pneumatic gun any hit counts. If it were a mast or smokestack, the detonation of 200 pounds of high explosive, even 50 feet up in the air, would leave very little fight in the neighboring part of the ship; if it should fall short by twenty or thirty yards it would be still more effective, because, being fitted with a delay-action fuse, it would detonate in contact with or close under the bottom. So that if the fire is less accurate ideally, the chances of an effective hit are not by any means reduced in the same proportion.

An important feature in the question of accuracy is the flatness of the trajectory under water, by which the danger space is greatly increased. The ogival shape of the head and the position of the centre of gravity of the projectile (about 45 per cent. from the point) apparently combine to make it assume a more horizontal position after striking the water, and it scurries along so near the

surface as to produce a noticeable disturbance. At the firing of the first 15-inch gun at Fort Lafayette, before a naval board in January, 1889, the depth of water (31 feet) and the distance between the points of fall and of delayed explosion (53 yards), indicated, at one of the shots, that the total trajectory under water was at an angle of minus eleven degrees; but as the surface swash was plainly visible throughout much the greater part of the distance, it follows that the descending branch of the trajectory was abrupt and short.

During the ranging of the guns of the Vesuvius in January, 1893, theodolite angles gave an average of about 50 yards as the distance that the shell traveled near enough to the surface to be detected. Subsequent observations seemed to reduce this distance somewhat but it is undoubtedly considerable. Furthermore, as bearing upon the chances of a successful shot, actual contact under water is not necessary to produce detonation; if the delay-action fuse, ignited by striking the water, detonates a 200-lb. charge under or anywhere within 10 or 15 feet laterally from the hull, a destructive effect will be produced even if the double or triple bottom be not actually crushed in. The fact remains indisputable that the shot referred to at Fort Lafayette would have fatally torpedoed a vessel 50 to 60 yards beyond the point of fall.

The prompt ascertainment of the range is certainly the most serious question. In cases where the enemy is advancing and changing his distance rapidly, it will be difficult to regulate the fire successfully; but even here there is a slight compensating element in the fact that the length of the enemy's ship (say 300 feet) would be in the line of fire, and the shot would be effective if it hit anywhere between his taffrail and say thirty yards ahead of him; that is, the effective target would be about 130 to possibly 150 yards long.

Another salient point in the controversy is that the guns being very long—fifty-five feet—the firing interval is much greater than in high-power guns. In the latter, roughly speaking, it is probably not far from two one-hundredths of a second, from the time the fire is communicated to the charge; just what it is in the pneumatic gun is not known, there having been no opportunity to measure, but it is considerably more owing to the low velocity in the bore and the time required to complete in succession the recip-

rocating motions of two pistons and one cylindrical valve. In both cases what might be called the *practical* firing interval, that is, the time which elapses between the instant when the gun captain begins to try to fire and the instant that the projectile clears the muzzle, is very much greater, being according to Lieutenant Meigs,* about one-seventh of a second in a powder gun; in the air gun it is correspondingly greater, and if the vessel is pitching the elevation becomes changed in that time and vitiates the practice. On the other hand, it must be remembered that with curved fire a slight change of elevation makes much less difference in the range than the same change would with a flat trajectory.

A more serious difficulty in pointing is encountered when the vessel is rolling, as a source of lateral error is introduced which can only be overcome by the skill of the firer,—as indeed obtains with all guns and torpedoes afloat.

It appears then, that of the various elements which effect the general efficiency attainable at sea with pneumatic discharge, several are conflicting; just how far these will neutralize each other is an interesting point, and one which probably cannot be precisely determined without a certain amount of target practice.

On board a vessel of the size of the Vesuvius, elevating and depressing a 15-inch gun 55 feet long is quite out of the question, and no attempt has been made to vary the range by that means. Indeed, air being of such universally equable nature (as regards its elastic and expansive properties) and being consequently so easy of control, the problem of varying the range is best solved by varying the initial velocity. When installed on shore or in a large vessel, where there is plenty of room, the range may be greatly increased by increasing the elevation beyond the minimum angle at which non-ricochet is certain. In developing the tactics of the army guns, it may perhaps be found best to adopt a limited number of standard angles, and vary the range between those points by varying the I. V. Of course, as the angles increase, the number of increments of variation between successive angles will decrease.

In a small vessel, however, we are practically limited to one

*Lectures on Naval Gunnery. I understand that experiments carried on by Captain Sampson, U. S. N., give a considerably longer interval, but in any event, the pneumatic gun labors under a disadvantage in this comparison.

angle of elevation, unless much shorter guns be adopted, and a higher pressure, which is not desirable beyond certain limits, because increasing the air pressure does not increase the power and range in the same proportion. The additional weight of air to be moved affects the result very materially. It is a fact which at the first glance may appear surprising, that when the reservoirs of the Vesuvius are pumped full, the weight of air contained is several tons, enough to affect the vessel's draught over a quarter of an inch.

Mechanically considered, there are two ways of varying the I. V.: first, by varying the initial pressure; second, by using a constant initial pressure and varying the amount of air admitted. The former might be likened to varying the quality of powder in a powder gun, and the latter to varying the size of the charge. The most accurate results can probably be attained by varying the initial pressure, and firing for the maximum range with such pressure, as was done in the Silliman trial; but it is quite evident that that would not be practicable in naval service. Under the changing circumstances of battle it might frequently be necessary to jump suddenly from a short to a long range, and if the storage reservoirs were not under very high pressure there might not be air enough to increase the pressure in the firing reservoir, or not enough to do it quickly. Still greater would be the difficulty if called upon suddenly to change from maximum to a less range; a lot of air in the firing reservoir would have to be gotten rid of; it could not be returned to the storage, as the pressure is greater there; it would have to be blown out in some way and lost, and the air compressors would probably take an hour or more to pump up the amount thus wasted.*

*This method is criticized in its application to guns mounted on shipboard, that being the subject of this paper. It should be observed that in the service of guns on shore, although uneconomical of air, it may prove efficient, as producing the most constant I. V.; the ability to change the elevation will reduce the number of different pressures possibly required, and the relative movements of an enemy are not as rapid in engaging a fort as in a wholly naval action. If employed, the most practicable mode of application would seem to be to adopt a limited number of initial pressures and vary the ranges between by changes of elevation.

In the same way, the plan of changing the volume of firing reservoir open to the gun (mentioned in the next paragraph) might be used in a stationary

The second method, therefore, is preferable, *i. e.*, to keep a constant initial pressure and vary the amount of air used. There are three ways of doing this: one is to vary the length of time that the main valve is open for admitting air behind the projectile; another is to keep the main valve open the same length of time, and throttle the air supply differently for different ranges; the third is to vary the volume of firing reservoir opened to the gun.

The first method was adopted in principle by the Pneumatic Gun Company, and has been adhered to by them. Many different mechanisms have been devised and patented, but the same underlying principle governs them all, the required time element being obtained by the passage of a certain volume of air through an orifice; by screening this orifice with a micrometer movement very delicate variations of area and consequently of time can easily be effected, and the theory is that the increments of I. V. and of range vary exactly and always with these increments of area and time. If the hygrometric condition of the air that is supplied be kept uniform, there seems to be no doubt that the theory is correct.

A detail description of the mechanism would be out of place in a general, tactical study of the subject, but it must be stated in broad terms that the communication between the firing reservoir and the gun is closed by a large cylindrical valve called (in the Vesuvius) the main valve. This is kept in its forward, or closed, position by the air pressure on a large surface at its rear end; the same pressure acts on a much smaller surface at the front end, tending to open it when the pressure is relieved at the rear. The function of the mechanism called the auxiliary or range valve is to afford an outlet for this rear pressure, and then restore it after the lapse of a short and variable interval. The varying of this interval is effected by screening the regulation orifice as spoken of above, thus regulating the time the main valve is open, the amount of air consequently admitted, and the resultant I. V. and

emplacement, fitting quick-working stop valves to isolate and confine certain portions of the reservoir, and resorting to changes of elevation for intermediate changes of range.

Difficulty may be experienced with both these methods in effecting short ranges with angles of fall great enough to insure non-ricochet; and farther objection might be urged in the necessity of ranging the gun independently for each pressure or volume.

range. Of course these increments of time are infinitesimally small, but so amenable does air seem to be to control that a remarkable accuracy has been found possible.

It is a feature of this general problem that the control of the air as effecting the range is more perfect at the higher ranges. There being no such thing as absolutely perfect mechanism, there are bound to be small errors in the time element; when these errors form a part of the longest time of opening (corresponding to maximum range), the percentage of error and its influence on the range will be minimized; also, as the pressure falls during the completion of a shot, and the rapidity of flow of air decreases with the difference of pressures, the additional or subtractive amount of air admitted to the gun during the small increment of time that the action of the valve may be in error will be least when the pressure is least (after the greatest loss). Furthermore, physical conditions as to variable friction exist as much in the short times of opening as in the longest, and therefore the percentage of error from this cause will also be least with the maximum time of opening. Finally, on account of the weight of air to be moved, the curve of ranges and losses will be so flat near its superior limit that quite a large discrepancy of air-loss will have but a slight effect upon the range.

We may therefore expect the greatest longitudinal accuracy at the greatest ranges.

An impression is sometimes detected that the delicacy of this breech mechanism is such as to militate against its serviceableness. This is a misapprehension. The parts are not delicate, and the assemblage is not intricate. It is not complicated either in function or maintenance. Assuredly the works of one of the service automobile torpedoes, without which no modern armament is considered complete, are far more complex and more liable to need adjustment, and require greater care and skill in manipulation. This remark must be coupled with the further positive statement that it is advanced only to correct an erroneous impression regarding the former weapon, and not as an attack on the torpedo in either a comparative or a positive sense. The latter accomplishes feats which even yet excite the wonder and admiration of mechanic and tactician alike; but these marvels have now become a necessity, and impose the obligation of a more carefully trained

personnel. It is impossible to fulfil modern requirement without the exercise of a certain amount of intelligence and skill. If absolute simplicity be required, we will have to go back to the dear old muzzle-loading 9-inch smooth bore on a Marsilly carriage.

The first auxiliary valve for a 15-inch gun was tried at Fort Lafayette; it is called the Pratt valve from the name of its designer. It worked fairly well,—very well for that stage of development, but it possessed one feature which rendered it unsuitable for use on a moving platform: to insure uniformity of action a slight delay or pause (in order to completely empty a bulb) was necessary in its manipulation. With a gun mounted on shipboard, where it is desirable that even the firing interval should be as short as possible, of course it is out of the question for the firer to have to pause in the act of firing when the sights are on.

So the field was still open, and several models were made and hastily tried, and finally the Sewall valve was considered satisfactory and accepted. It was the best of those produced at the time, but had two defects which were not fully appreciated until later: its working was slightly affected by the greater or less quickness of pulling the firing lever, thus introducing a personal error; and the regulation orifice was such a narrow slit that a particle of carbonized oil, for instance, could lodge there, make a sensible diminution of the area, and affect the time of closing the main valve.

Recognizing the undesirability of these two features, and being anxious at the same time to test the method of throttling the air in competition with that of varying the play of the main valve, the officers of the Vesuvius at the time of her commissioning cast about for means of experimenting in that line, and were so fortunate as to learn that throttles for that purpose had been made and were still in the possession of the contractors. Captain Zalinski, U. S. A., whose name is so well known in connection with pneumatic guns, had always been a strong advôcate of the throttling system, arguing very forcibly that an area 15 inches in diameter is capable of finer and more accurate subdivision than so small a one as that of the regulation orifice. These throttles had been made, presumably in deference to his opinion, but had never been tried. They were obtained, and one was fitted in place, graduated and put in working order by the officers and seamen-gunners of the

Vesuvius. This involved a considerable amount of trouble and labor and experimental blank firing; the auxiliary valve, of course, had to be retained, to make the main valve function, the difference being that as screening the orifice was done away with and it remained of a constant size, its shape could be changed so long as the proper area was maintained. A round hole is manifestly better than a narrow slit, being less likely to be partially choked; it therefore became necessary to determine and effect the exact size (approximately 1-16 inch in diameter) which would cause a maximum loss of about 120 lbs. pressure in the firing reservoir with the throttle wide open. This approximate loss was hit by the following course of reasoning:

The assumption was made that the I. V. would not be sensibly increased by admitting more air than required to follow the projectile at full pressure for more than three quarters of its travel. The volume of the firing reservoir is about 276 cubic feet; the volume of three-quarters of a gun bore, including chamber space, is about 52 cubic feet. The initial pressure was 750 pounds. The final pressure, therefore, after a shot in which the air is admitted until the projectile has traversed three quarters of the bore, would be approximately found by the equation

$$276 \times 750 = (276 + 52)\,x$$
$$x = 631.$$

The loss of pressure then would be

$$750 - 631 = 119.$$

The assumption and computation are not correct to a degree which would be required in a laboratory experiment, because of the fall of temperature, the work required to move the air, and the wiredrawing of the air; but they were found to be sufficiently so for all practical purposes.

The labor of trying, enlarging or diminishing, and again and again trying this small round hole was a good deal increased by the fact that as there are no stop valves to isolate the guns, no part of the mechanism could be gotten at for alteration without first blowing all the air out of the firing reservoir. But it was finally done, and the gun thus fitted pulled the Vesuvius through the first (abortive) trial, in May, 1891.

While dealing somewhat with mechanical details, it may be as

well to give here an idea of the system of pointing proposed by the officers of the Vesuvius.

Although the guns are stationary in the ship, a line of sight is just as necessary as in pointing guns that are capable of independent train and elevation. This is very obvious as regards the lateral direction. In regard to the vertical plane, the guns being ranged at a certain elevation, that is, with the vessel on an even trim, subsequent firing should be always done when the same angle exists,—that is, when a line which was horizontal at the time of ranging is again horizontal or pointed at the enemy. A fixed line of sight is therefore required, parallel to the fore and aft line of the vessel and horizontal when on an even trim; and the principles of pointing are the same as with any other gun, the only difference in the practice being that the rear sight of the pneumatic gun is not changed for range.

A line of sight about 53½ feet long suggested itself from observing that the centre of the sight slit at the firing levers in the tower was approximately in a fore and aft line with the middle of the space between the muzzles of the starboard and middle guns. The advantage of so long a sight radius need not be commented upon. The only difficulty was that the muzzles came just high enough to obscure the field through certain arcs on either side, the clear sector between them not being broad enough for pointing when allowance had to be made for a strong beam wind, or high speed of enemy. It was proposed to get around this difficulty in the following way:

A rear sight, with eye piece movable transversely, was designed for the sight slit; and a fixed one for the muzzles. The latter consisted of one horizontal ⅜-inch iron rod, and three vertical ones, the middle one midway between the muzzles, and the other two at 10 inches on either side, there being 20 inches clear field; the horizontal rod and the horizontal wire of the rear sight were on a level, with the vessel on an even trim. The lateral travel of the rear sight was made 10 inches, five on either side of the centre; when at zero (at the centre) it made a fore and aft line with the front middle rod; to allow for wind, etc., it could be run off to one side (say to the left) five inches; in case still more allowance were needed, it will be observed that a line from the right hand end of the rear sight past the right rod of the front sight

is parallel to that from the left end of the rear sight past the middle rod; to obtain a greater angle, therefore, it is only necessary to run the rear sight over to the right and ten more inches become available. In this way there is obtained what amounts practically to a travel of the rear sight of 15 inches. This rear horizontal sight bar is graduated, and the eye piece is moved by a worm.

The sight radius being about $\frac{1}{100}$ of a mile, the 15 inches would allow for a lateral displacement of the projectile of 1500 inches, or 125 feet, at a mile range. The amount that the projectile is drifted by the wind had been estimated at $\frac{1}{1000}$ of the range for every mile of wind velocity across; at that rate, 125 feet would allow for about 24 miles of wind. This estimate appears to be a little excessive; circumstances have not yet permitted a close determination, but as a matter of mere judgment from watching the falls and estimating the force of the wind, it seems that a less allowance would be admissible. Of course, a beam wind of 24 miles, with corresponding sea, would not constitute conditions under which it could be hoped to do much with the Vesuvius. As a matter of fact, engagements under such conditions have been extremely rare; practically all fights between modern vessels have been in smooth water.

The same graduations of the sight bar are applicable to the motion of the enemy, but their use is not necessarily contemplated for that purpose. The maximum lateral deviation obtained would only compensate for a speed of 6¼ knots across the line of fire. If, besides sighting along the line of greatest allowance, the gun be pointed at the bow of a vessel 300 feet long, the shell would strike somewhere between the stem and the stern if his speed were between 6¼ and 21¼ knots. As this speed is more apt to be between 0 and 15 knots, the best rule would be to use the fore and aft line of sight and aim at his bows, unless a big wave or the action of his smoke, or some other sign, should indicate a very high speed.

With the enemy bows on or stern on, no such element enters; and in this case, as mentioned before, the probability of effective accuracy in range would also be greater. For both reasons, therefore, the most advantageous position for a pneumatic gun vessel is generally ahead or astern of the enemy (and going the same way so as to keep the range approximately constant). An exception would be in the case of there being a sea on, making the ves-

sel roll; under such circumstances it would be better to have the length of the enemy for the breadth of the target. It would also undoubtedly be better, if possible, to take the sea ahead, or better yet astern, as the errors in range due to pitching or scending would be less than the lateral errors due to rolling. With the sea aft, the motion will of course be less disturbing than when pitching into a head sea, and the practice proportionately less affected.

It may rarely be possible for a single vessel to choose position with regard to both sea and enemy. An attempt might, however, be successful to gain the *weather* gauge, so to speak; and then if the enemy were to head for you, as would be his best plan (or steer in the opposite direction), the entire desired conditions would be obtained. If vessels of this class hunt in couples, which seems to be by far their best tactics, they should find no great difficulty, by separating, in gaining the right position for one or the other.

The method of pointing suggested and described above seems crude as compared with the fine sights produced at present and applied to these guns on shore mounts. But apart from the limiting of the field by the muzzles, it was thought that in view of the probable motion of the ship, poor light in the tower, and the nervous tension due to the circumstances, better results would probably be achieved with the coarse graduation permissible with a sight radius of 53½ feet, than with the fine graduation necessary for a short distance between sights, especially such as would be had if a telescope were used. Moreover, as the relative force and direction of the wind will be always changing with the course and speed of the vessel, they can at best be only estimated, and it would be an unnecessary and troublesome refinement to use a vernier in allowing for them. The human eye, the human hand, and human nerve may be amenable to cumulative training as the generations pass; but it is always wise to adapt instruments to the actual capacity of those who are to use them, and to the conditions under which they will be used. *Sicut erat in principio, et nunc, et semper.*

As regards ammunition, four standard sizes of shell had been determined upon, carrying respectively 500, 350, 200 and 100 pounds of explosive; the first is a full-calibre projectile, and the others of different sub-calibres. The extreme range naturally decreases with increased weight, and it was considered that the 10-inch shell hold-

ing 200 pounds, and weighing in all about 500 pounds, with an estimated range of about 2100 yards, would best satisfy general requirements, and would amply demonstrate the capabilities of the gun. Those used on the trial were blind shell, or dummies, of this type, being of the same size, shape, weight and position of centre of gravity as the loaded shell, so that the ballistics would be identical.

This sub-calibre arrangement is a very excellent one. The projectile, say ten inches in diameter, is centred in the bore and fitted with a gas-check of full calibre; it therefore receives the impulse of full pressure on an area of 15 inches diameter, but experiences during flight only the resistance of an area 10 inches in diameter, thus materially increasing the range. It also renders possible the attaching, to the outer circumference of the rear end, of the diagonal vanes which steady the flight so successfully.

In the trial of May, 1891, owing to a lack of conveniences and material, no results of much importance could be obtained. Only thirty projectiles had been provided, no sight fitted, and no opportunity given to range the guns, in which condition it would be largely a matter of guesswork whether the shell would go 500 yards or 1500. The Board did all that was possible; a simple jury sight was rigged, without wind attachment, and some of the projectiles were used for ranging the starboard gun, a curve being obtained which was as good as was possible with the limited supply of ammunition and the poor facilities at hand for measuring distances. This starboard gun was the one fitted with the throttling arrangement described above; the other two started off with some wild firing and were dropped for lack of ammunition.

The general plan of the trial was to first fire a certain number of shots at a stationary target, the vessel moving in some cases slowly, and in others at a high rate of speed; afterwards, three shots were to be fired at a cutter moving directly across the line of fire at the rate of 10 knots an hour, the Vesuvius going about 17 knots. The fixed targets were spar buoys.

One clause in the instructions to the Board exerted a considerable influence on the apparent result as reflected in the Report. This clause was mandatory that the firing should be "by word of command." The only person in the vessel able to know when the sights are on is the captain at the firing levers in the tower;

and, whether going fast or slow, to keep a vessel accurately pointed on a spar-buoy half a mile to a mile away is a manifest impossibility; it is impracticable with a gun capable of quick and easy train; and it is therefore not suprising that the word to fire should have come frequently when the vessel (and gun) was not pointed at the target, but a little off, making the gun apparently in error to the amount of sometimes fifty yards laterally.

In spite of this, however, and including those apparently wild shots, the record shows that of the nine that were fired at a stationary target, from distances varying between 880 and 1760 yards, one was a "bull's eye," and three, or 33 per cent., would have struck a vessel 300 feet long by 20 broad, head on, supposing her height out of water to be 15 feet; probability of hitting smoke-stacks, military masts, davits, etc., not counted. Rejecting the lateral errors due to firing by word of command, the number of hits reached seven, or 78 per cent.

Coming now to the practice at a moving target, it may be safely said that to advance at the rate of 17 knots and fire at a ship's cutter half a mile to a mile away, crossing the bows at the rate of 10 knots, constitutes a more crucial test than has ever been imposed upon any other weapon. The time of flight being about 12 seconds, the lateral displacement of the target during the flight was about 200 feet; in such a case, without wind or speed-of-enemy attachment on the sight, and the boat frequently lost in the white caps and spray as it bounded from crest to crest of a moderate sea, it is evident that much would devolve upon the judgment and skill of the firer, who had to steer the vessel on a curved course and *keep* pointed at an estimated distance of 200 feet ahead of that moving speck, and much also upon the adaptability of the gun to extraordinary circumstances. And yet under those severe conditions one was a line shot, and the maximum lateral error (at a mile) was less than the deviation allowed for the acceptance of the service automobile torpedoes when fired from a fixed platform, in smooth and still water, at a stationary target 800 yards off. As regards the total accuracy, longitudinal and lateral, one shot would have struck a vessel; regarding which the Report says: "This the Board considers a favorable showing under the circumstances."

It is proper to state, in fairness to both sides of the question, that the range was obtained by sextant angle of the cutter's tow-

line, and at the second shot (from three-quarters of a mile) this was not at right angles to the line of observation, and the actual range was therefore less than that for which the throttle had been set. It was afterwards roughly computed from the compass courses of the Vesuvius and of the torpedo-boat towing the cutter, at the moment of firing, that the error in range approximated quite closely to the estimated amount (300 yards) that the shot went over, and therefore, if the correct range had been given the gun would have scored another hit. This shows work more accurate than appears on the surface, and more satisfactory than was expected; but it also emphasizes the necessity of knowing the range, and shows that it is futile to expect fine work of the weapon under circumstances which preclude such a knowledge. In active service, of course, the target will not be an object so devoid of military masts, smokestacks or other objects of approximately known height as a ship's cutter, nor of so little length that the vessel will have to be kept pointed into vacancy at a considerable estimated distance ahead of it.

At this time the suggestion was made that a good "service" way of handling the pneumatic battery would be to fire all three guns at once for ranges differing 50 yards,—the mechanism of one being set for the supposed range, one of the others for 50 yards more, and the third for 50 yards less. This would make up for a considerable error in the measurement or estimation of the distance, and the probability of a hit would be much greater than if three separate shots were fired. The danger space of a moderate sized vessel, even broadside on, exceeds 50 yards, so that the simultaneous shots could not span the target; and although in firing separate shots the range could be verified by the first one, it might under some circumstances be materially changed before the second. In firing simultaneously at a vessel end on, it would be possible for all three to take effect. To prepare for this firing tactics would require the expenditure of a few extra blind shell to establish the additional corresponding range curves; because, while the initial pressure would be the same in the two cases, the final pressure would be less when the three guns were fired than when only one was fired, and the I. V. and range would therefore be less.

The possibility of using, and the desirability of experimenting with linked projectiles was also suggested, but not heavily weighed upon.

The trial, while not conclusive as regards the capabilities of the gun, made it patent to the Department that the system had been underestimated, and it was decided to install and try the Rapieff range mechanism, which had been previously asked for, and which is the *dernier mot* in pneumatic ordnance.

The regulation orifice of the Rapieff valve being very much larger than in those originally installed, the advantages of the throttle system for controlling the range would be less accentuated with it, while the disadvantages remain undiminished. One bad feature, to a certain extent inherent to it, is that the labor of moving the throttle under proper conditions of air-tightness and accuracy of graduation is such as to require two men and a material length of time to change from maximum to minimum range, or *vice versa*, while with the Rapieff regulator the change is made in a few seconds by the gun captain. The use of the throttle is also uneconomical of air at short ranges (when the throttle is partially closed) because of the air being somewhat wiredrawn and less efficient in application. One prohibitory feature of the method, as installed in the Vesuvius, is that the volume of the air capacity existing between each throttle and its gun is a sensible proportion of the total capacity of the firing reservoir, and throttling down one gun therefore affects the volume of air available for free admission to the others, and vitiates their practice. This defect, of course, may be obviated in future vessels by placing the throttles close to the guns.

A comparison of the accuracy possible with the two general methods under proper conditions would be most interesting; but the position of the throttles has made that impossible with the guns of the Vesuvius.

There was a considerable delay in installing and trying the new mechanism, owing to causes which are not of interest in this discussion; but the trial finally came off in January and February, 1893, and the Report of the Board has been published in the Annual Report of the Chief of the Bureau of Ordnance.

Very early in the work of ranging the guns preliminary to the trial firing, the presence of an enemy was detected which had not been suspected before; or, more correctly perhaps, its importance had been underestimated. That enemy was water in the air, with oil, also, from the compressor. Up to that time, there had been

none but blank firing with those valves; and while it had been noticed that the various surfaces, including seats and buffers, were quite wet after a firing, there was nothing in the results to call particular attention to it. The pressure gauge read to only two pounds, and as it had been in use a long time its indications of losses were not thought to be especially exact; also, no doubt was entertained of the correctness of the assumption that, deprived of the steadying effect of the projectile, the air losses would be less regular and repetitions less good in blank firing that when shotted rounds are fired; * for these reasons, occasional aberrations in the amounts of air used had not led to an investigation close enough to probe the matter to the bottom.

Being on the ground, ready for trial, there was nothing to be done but to diminish the evil results, as far as possible, by keeping the seats and buffers in good order. Boiling them in paraffine-wax was found to have a good effect. That was of slight importance, however, comparatively. The way in which the moisture probably does the most mischief is, briefly, as follows: a hollow bulb of a certain capacity in the auxiliary valve has to be filled to pressure (through the regulation orifice) before the return movement of the main valve is effected; if a little water enters the bulb with the air, the expansive force of the latter will be modified, and the vigor and velocity of the return push varied; also, the water entering through the regulation orifice occupies a portion of its section in passing, and reduces the area available for air, producing the same effect as that of screening more of it by the regulator. There would undoubtedly be a direct effect on the total pressure exerted on the base of the projectile if a serious amount of water were present; but it appears likely that the vitiation of the action of the auxiliary valve, and through it of the main valve, has much the most to do with the final result.

It will be noticed on examining the tabulated results of the firings, that the middle gun did the best work; and, in connection with that, it is interesting to note two things. When preparing for active service in the winter of 1891–92, the main valve of the

* The correctness of this assumption was well established when the opportunity came to fire projectiles; there were frequently differences of 10 pounds in the air losses of blank and shotted rounds for the same valve setting.

middle gun being defective, a new one was ordered, and advantage was taken of the opportunity to modify the design to the extent of interposing an air cushion at the front seat to diminish the blow of the return (closing) stroke. It was thought that incidentally this might affect favorably the regularity of the cut-off, and it is quite possible that some such improvement resulted; but the most important feature connected with the middle gun is the comparative (not positive) immunity of its auxiliary valve from water. The supply pipes from the storage to the firing reservoir deliver the air under and quite near the auxiliary valves of the starboard and port guns, and any moisture brought and deposited there is apt to be aspirated up into those mechanisms. It would, therefore, be natural to expect that less water would reach the middle gun than the others, and, as a matter of fact, there was less trouble with its seats and buffers from that cause. This, taken in conjunction with the better shooting of that gun, certainly tends to confirm the expectation that if the moisture could be eliminated, the accuracy would be improved.

The poorest showing was made at the 500-yard range, and the Board practically gave up that part of the programme, regarding which the Report says: "It was judged best to develop the accuracy of the guns at the more distant ranges, rather than at 500 yards, it being considered that the greatest usefulness in warfare of the pneumatic system as installed in the Vesuvius would be beyond the range of 500 yards."

The correctness of that view seems incontrovertible, but it would nevertheless be desirable to maintain, if possible, the efficiency of the weapon down to minimum ranges, and there does not seem to be any reason, mechanically, why the auxiliary valves should not be made to function for small as well as for large losses.

The only external element liable to affect the practice at short ranges is the variable friction in the bore, which then bears a larger proportion to the total resistance to projection than it does at the longer ranges produced by a stronger impulse and higher I. V. But while this may indeed make an actual difference in the velocity, that difference cannot amount to much, because the rubbing surfaces have a very small total area; the centering pieces near the point take on about one-half of the circumference of the bore and are only about 3 or 4 inches long; the centering sabot at

the base is of about the same length, and the friction of the gas-check on it is the same in all cases, because the leather cup which forms it is always of the same length, and is expanded against the wall of the bore by the one constant pressure in the firing reservoir. The lubrication of the bore by the oil in the air at each discharge would remedy any slight inattention on the part of the division officer.

So it is difficult to lay the trouble at the door of any external condition; and it is easy to conceive that the final effect of the presence of moisture in the air on the working of the main valve is more accentuated at short ranges owing simply to two facts: first, the entire functioning of the pistons, etc., is more rapid, and therefore any disturbance bears a larger proportion to the total time of working; second, when the air is cut off at very short stroke the effect on the range of a certain error in effective air-loss is much greater than when it follows to more nearly full stroke.

There should be no great difficulty in eliminating this oil and water. It may be almost impossible to keep them out of the storage reservoirs, but they can certainly be kept out of the firing. To this end, it has been proposed to put a centrifugal separator between the two groups, at the same time leading the supply pipe between them to a point in the firing reservoir most remote from the guns, and fitting a pocket and drain there. This will cost very little and will undoubtedly have a very marked effect, and it is hoped that the suggestion will be adopted, although it is understood that nothing more is to be done until after the trial of one of the army guns.

In spite of the trouble with water, the guns made a very fair record, as is shown in the following table of probable effective hits, extracted from the Report of the Board and based upon the actual practice. The assumed target was the Philadelphia, and her dimensions were taken as follows: Length, 320 feet; beam (mean), 33 feet; freeboard, 20 feet. The danger space, or beaten zone, due to the sub-surface travel was taken at 30 yards, and the radius of effect of detonation at 7 yards. (The Report says about this last feature: "Observations referred to . . . . show that the effective under-water run is probably more than this, but the figure 37 has been retained in the computations as being on the safe side.")

ENEMY BROADSIDE TO.

STARBOARD GUN.	At 2,000	yards	41.2	per cent. of hits.
	" 1,500	"	56.	" " " "
	" 1,000	"	35.6	" " " "
MIDDLE GUN.	" 2,000	"	79.	" " " "
	" 1,500	"	43.5	" " " "
	" 1,000	"	26.7	" " " "
PORT GUN.	" 2,000	"	55.9	" " " "
	" 1,500	"	30.6	" " " "
	" 1,000	"	23.9	" " " "

ENEMY END ON.

STARBOARD GUN.	At 2,000	yards	73.4	per cent. of hits.
	" 1,500	"	81.8	" " " "
	" 1,000	"	64.3	" " " "
MIDDLE GUN.	" 2,000	"	93.8	" " " "
	" 1,500	"	62.2	" " " "
	" 1,500	"	49.8	" " " "
PORT GUN.	" 2,000	"	81.9	" " " "
	" 1,500	"	59.9	" " " "
	" 1,000	"	47.5	" " " "

This table certainly bears out the statement of the Board that the system "is of decided value in naval warfare." And when the future improvement is effected, which is indicated by the present superiority of the performance of the middle gun, there will be a great gain in adaptability to service conditions. This farther improvement is undoubtedly a necessity, because that 94 per cent. of hits, for instance, was possible only with an exactly known range; and however excellent and serviceable our range-finders may be, firing will often have to be done under circumstances precluding a precise ascertainment, and then the accuracy of the guns must be such as to cover a moderate error of appreciation of distance. But I believe (and I hope I will be corrected if I am wrong) that it is the opinion of all the officers who have been associated with those guns, or who have been so situated as to be able to watch and understand their working, that they will unquestion-

ably soon attain the mechanical accuracy of landing practically 100 per cent. of shots in a rectangle 25 yards long.

A curious fact noted during the trial was that some of the projectiles ricocheted. Each one was watched from behind as it sped away from the vessel, and while a slight wobble could be sometimes detected in the very early part of the flight, they all seemed to settle down quickly to a smooth steady motion. In the greatest gyrations observed, the base of the shell would describe a circle having a total diameter estimated at 2 to 2½ diameters of the shell; that is, the rear end of the axis described a circle of a maximum diameter of possibly 10 to 15 inches; it was generally much less. By good fortune, one of the shells fired at a beach entered the sand, and its trajectory could afterwards be followed and was quite similar to what it apparently is under water; it ranged 50 feet through that hard sand and mud, in a practically horizontal path, coming once near enough to the surface to "breach," and finally coming to rest a couple of feet below the surface and pointing downward at an angle of about five degrees. Apart from the unexpectedly great penetration effected, a most interesting fact noted was that the undulation of this subterraneous trajectory was not simply in a vertical plane but slightly gyratory, showing that the gyratory momentum was sufficient to maintain that movement even in such a resisting medium. The point being established that this one shot had a gyratory motion at the end of the flight in air, the question naturally arises as to whether others do not continue to wobble slightly; and if in this motion the point should happen to be *up* at the instant of striking, would the decreased angle of presentment, so to speak, possibly cause a ricochet?

The fact that the ricochet was sometimes straight and sometimes a little to either side would be accounted for by the differing positions of the shell in the different periods of its supposed gyration. As it was, there were few instances of this action, and in no case did the divergence seem sufficient to clear the half-beam of a vessel of moderate size. If it was caused by wobbling at the end of the flight, it indicates that the angle of fall and consequently the elevation of the guns is the least admissible. The means of correction would be in the direction of putting the centre of gravity of the shell a little farther forward and of increasing the surface of the diagonal vanes which impart the rotary motion. An improve-

ment on these lines would, of course, also increase the regularity and duplication of the ranges attained.

The fact of the projectile ranging about 50 feet horizontally through the sand is a strong corroboration of the Board's estimate of 42 yards for the average effective under-water run. The shell would not start downward from its weight in the water until its headway was practically stopped; and if its momentum carried it 50 feet through sand and stiff mud, it would certainly carry it three times that distance through water.

The judgment of the Board, based upon careful observation, that the length of under-water run is practically the same for all ranges, may seem at variance with the probabilities of the case, considering the greater momentum the projectile has at the greater ranges; but the apparent discrepancy may be accounted for by two elements which enter into the problem: (*a*), the angle of fall is greater at the greater range, and more work is absorbed in the change of direction on entering the water; (*b*), at the lesser ranges the axes of these shell are less nearly tangent to the trajectory than at the higher ranges, and they are therefore more nearly horizontal at the instant of striking, and their change of direction is thus farther reduced.

(*a*). It is the resistance of the air that makes the angle of fall greater than the angle of departure; the less the I. V., the less will be the resistance, and the more nearly equal the angles of fall and of departure. An attempt has been made to obtain and compare the angles of fall of these shell for different ranges, using the formulæ deduced from the experiments of Bashforth and of Krupp, and given in different text-books. As these projectiles are 9½ calibres long and fitted with projecting vanes, their ballistic coefficient differs materially from that of standard shell, and has to be determined. The times of flight not being given in the Report on the Port Royal trial, the data is insufficient, the I. V. never having been measured; but with the ranges and time recorded in the trial of May, 1891, and the angle of departure, the coefficients of form have been sought by the tentative method suggested in Ingalls's "Handbook of Exterior Ballistics," and which was followed by Colonel Farley, U. S. A., in determining the I. V. of a similar gun at Cold Spring, New York. (See Annual Report of the Chief of Ordnance, 1890.) Use was made of Ingalls's tables which have recently been

extended to comprise the ballistic functions of values of v down to 300. The calculation is given below for a mean range of 6001 feet, the results, neglecting fractions, being, I. V. = 669; F. V. = 450; angle of fall, 23° 25';* there is reason to believe that this is not far

$$* \; X = C\,[S_u - S_v]$$

$$T \cos\phi = C\,[T_u - T_v]$$

Dividing: $$\frac{T\cos\phi}{X} = \frac{T_u - T_v}{S_u - S_v}$$

$$X = 6001;\; T = 11.8;\; \phi = 18°;\; w = 512;\; d = 10.5$$

$$\frac{T\cos\phi}{X} = \frac{11.8 - .95106}{6001} = .00187 = \frac{T_u - T_v}{S_u - S_v}$$

Assume $V = 686$;

$$\frac{T_u - 12.234}{S_u - 13653.8} = .00187.$$

This is satisfied with $u = 425$; $S_u = 21777.9$

$S_v = 13653.8$	$\log X$	$= 3.77822$
8124.1	$\log$	$= 3.90978$
$C = .73865$	$\log C$	$= 9.86844$
$\frac{\sin 2\phi}{C}$		$= 0.79574$

$$\text{But } \frac{\sin 2\phi}{C} = \frac{A_u - A_v}{S_u - S_v} - I_v = \frac{16319.1 - 3422.5}{8124.1} - .80306 = 0.78427$$

$+\,0.01147$

Too large. Try $V = 669$;

$$\frac{T_u - 12.863}{S_u - 14079.6} = .00187$$

$u = 434$ $S_u = 21422.2$

$S_v = 14079.6$	$\log X$	$= 3.77822$
7342.6	$\log$	$= 3.86585$
$C = .81728$	$\log C$	$= 9.91237$
$\frac{\sin 2\phi}{C}$		$= 0.71918$

$$\frac{\sin 2\phi}{C} = \frac{A_u - A_v}{S_u - S_v} - S_v = \frac{15394 - 3777.03}{7342.6} - .86274 = 0.71939$$

$-\,0.00021$

$+\,1147$
$-\;\;\;21$

$1168 : 17 :: 21 : 0.3 \;\therefore\; V = 669.3$

from the actual. For materially shorter ranges, however, the results do not appear sufficiently satisfactory to serve as a base for absolute comparison. It seems likely that the various exponents and coefficients chosen to represent the mean resistances of projectiles of the ordinary type, between certain limits of velocity, are different from those required for the projectiles in question, and that the latter may also vary differently *inter se*. This is evidenced by the fact that the coefficients of form are different for different velocities when obtained by means of the constants that have been deduced from the experiments cited. With the idea that the retardation might approximate more nearly to that of spherical shell, the same computation has been made using the formulæ based upon the experiments of General Mayevski in 1868 (Table II. of Ingalls's "Handbook," and formulæ on page 15). The results, however, were wholly unsatisfactory and evidently erroneous. It is

$$C = \frac{w}{d^2 i} \qquad (\delta\beta = 1)$$

$$i = \frac{w}{d^2 C} = \frac{512}{110.25 \times .82} = 5.646$$

$$\text{Tan } \omega = \frac{C}{2 \cos^2 \phi} \left[I_u - \frac{A_u - A_v}{S_u - S_v} \right]$$

$$I_u = 2.54057$$

$$\frac{A_u - A_v}{S_u - S_v} = \frac{1.58213}{0.95844}$$

$$\begin{aligned} \log &= 9.98156 \\ \log C &= 9.91237 \\ \log \tfrac{1}{2} &= 9.69897 \\ 2 \log \sec \phi &= 0.04358 \\ \hline \log \tan \omega &= 9.63648. \end{aligned}$$

Angle of fall $= \omega = 23° \, 24' \, 44''$.

$$v = u \frac{\cos \phi}{\cos \omega}$$

$$\begin{aligned} \log 434 &= 2.63749 \\ \log \cos 18° &= 9.97821 \\ \log \sec 23° \, 24' \, 44'' &= 0.03731 \\ \hline \log v &= 2.65301 \end{aligned}$$

Final velocity $= v = 450$

be less than that of departure. The trouble is that an instantâneous photograph gives the angle that the axis of the shell makes at the given instant with a horizontal line taken in the same field; but when the shell is not tangent to the trajectory, the line of flight is not coincident with the line of position. The same trouble exists with the method of visual estimation, as the same picture is presented to the eye. The only way to determine the angle of fall optically is to take a non-instantaneous photograph, in which the path would be indicated by a streak.

Any deviation from perpendicularity of the line of observation to the line of flight will increase the apparent angle of fall; so that, while the actual angle may be larger than the recorded, it can never be less. The photograph, therefore, bears conclusive evidence that at short ranges the axis of the shell is at an angle of certainly not less than 2° or 3°, and possibly more, with the tangent to the trajectory; while at the maximum range the line of position of the shell is indicated as being nearly coincident with the calculated line of flight.

It was a great pity that the fuses used on this trial failed completely; there was not a single complete detonation and it is very doubtful if any of the primers were detonated. The principal thing that would have been gained if they had acted would have been a practical and more precise knowledge of the *efficient* length of the trajectory under water; theodolite bearings would have given the distance between the points of fall and of delayed explosion; a stop-watch would have given the approximate interval, verifying, or the reverse, the correctness of the desired estimated delay; and the column of water would have shown in a way if the depth reached was too great for good results. It does not appear that anything else would have been gained.

In all the Fort Lafayette firings the Zalinski electric fuse had been successfully used, tons of dynamite and gelatine being detonated with it. For the acceptance trial of the Vesuvius the contractors used Merriam's mechanical fuse, which also acted perfectly, the various time trains being right to within the limits of observation possible with a stop-watch; at the shot where no delay was interposed, the flash of detonation was seen above water as the point of the shell struck the surface, and the sound was that of a detonation in air. This fuse was lacking, however,

in that it only provided for detonation after a delay the length of which could be fixed only at the time of assembling the fuse.

For active service, such as seemed probable at the time that this last batch of live shell was ordered, it would be essential that the shell should detonate on impact with a solid body, but that a time train should be started by impact with water, so as to take full advantage of the invaluable feature of horizontal under-water flight. To this end the Rapieff fuse of double effect was designed, and on careful examination it appeared to promise excellent results. Its failure showed, of course, that the design was faulty; it was caused by one or possibly two out of three defects: First, the shearing pins of the safety sleeve were too heavy, the inertia of the sleeve not being sufficient to shear them at the time of discharge; second, the fulminate was too far from the dry cotton primer; third, the fulminate was weak, being of commercial make.

While it appears certain that the second defect did exist, there is little doubt that the first named was the cause of the trouble in most if not all the cases. After the repeated failures to obtain detonation on striking the water, it was thought possible that the shock of such impact was not sufficient to ignite the time train, and it was, therefore, decided to try the impact arrangement on the hardest surface available, namely a fairly hard sand beach below high-water mark. Two shell were dropped there from a distance of about a thousand yards. They did not detonate. On carefully removing the fuses, however, there was found in the condition of one of them a positive and interesting clew: the shearing pins were sheared, but a small bit of the steel spring for holding the ball in place was found to have been broken off and was wedged in one of the windows of the safety sleeve, a circumstance which could not exist except by the projectile striking the beach (and the ball breaking the spring) *previous* to those pins being sheared; it was observed that the shell on striking the beach turned a complete somersault and struck solidly again, farther on, base first; undoubtedly it was the violent shock of this second blow that sheared the pins, the effort being in the same direction as that of the shock of discharge, and more violent. It is, therefore, certain that the impulse for a range of a thousand yards did not liberate the safety sleeve. Whether or not the

impulse for 2000 yards would do it can only be surmised; if it did, then the fault was in the quality of the fulminate and its insufficiently intimate contact with the primer.

The necessary changes in the design of the fuse are, of course, easy to make, and have been made, and we shall no doubt have an opportunity to admire the efficiency of this perfected design when the Army gun is tested at Sandy Hook, or the Nictheroy's in Brazilian waters. It is understood, also, that the feature of double effect has been incorporated in the Merriam fuse, and as competition is the life of trade, we need have no fear of remaining without good ammunition for these guns. No doubt an efficient fuse of this kind could be gotten up by some of the officers of the service who have identified themselves principally with ordnance matters; but they have not yet bent their energies in that direction.

In studying the question of a new weapon and weighing the chances of successful action and of useful effect, with a view to deciding whether or not further expenditure of thought and money upon it would be judicious, one must be careful not to impose conditions too severe nor expect results too great, or a worthy and desirable object may be defeated. The intent should also be not to prove that conditions exist under which success would be impossible, but to ascertain if there are any conditions under which good results can be obtained. When the Vesuvius was still on the stocks, a critic pointed out that when advancing at 20 knots speed toward an enemy also advancing at 20 knots, the range would change so rapidly that the fire would probably be very wild; it occurred to that critic afterwards that it was in no degree necessary that the Vesuvius should continue to advance at full speed, but that she would probably slow down to mere steerage way immediately upon coming within range; or, if the vessel were properly designed with a gun pointing astern, she would turn tail and run away at about the same speed as that of the advancing enemy so as to keep the range about constant.

In a practical discussion of the merits of a new system, no harm but some good may spring from instituting—not comparisons, perhaps, but say parallels between it and others solidly intrenched in

general favor; this may save the error of setting too high a standard, a standard higher perhaps than would be sanctioned by a calm review of existing weapons and of what they have achieved.

To begin with the modern high-power gun: It will probably continue to be the foremost implement of war, but the fact must be recognized that in actions with it as the sole weapon, not nearly as great damage is done at sea as one would be apt to infer from proving-ground firings, permanent injury being rather the exception.

In the fight off Punta Angamos, in October, 1879, the Huascar stood up for an hour and a half against two Chilian ironclads which did their best to destroy her, as she would not surrender. She was completely vulnerable to their twelve 9-inch rifles, and gave a completely ineffectual fire in return; and during the ninety minutes that the action lasted the Cochrane made four attempts to ram, her consort made one, and the two together fired 76 9-inch shell, beside maintaining a constant fire from the smaller pieces which latter caused the blowing down of one of her boilers. Twenty of the heavy shell struck, or 26 per cent., and that was very generally considered good practice; and yet the sea was perfectly smooth, the enemy was little more than an inert target, and the firing was at very short range, varying from 500 to 5 yards; in fact, toward the end, the Chilians hung on the Huascar's quarter, pouring in a deliberate plunging fire from close aboard.

The victory was certainly won by the gun, the Peruvian being simply crushed by the overwhelmingly superior fire of two vessels each of which was of double her force; and yet that little vessel of 2100 tons received no permanent injury, and her adversaries failed wholly in their determined efforts to sink her. This was fortunate for them as they were afterwards able to take possession and add her to their fleet; but it was nevertheless a complete failure to carry out their purpose.

There was one point strongly accentuated in that action which is of particular interest in connection with the general subject now under discussion, and with a feature recently readopted in some of the latest types of vessels. It was shown that armor, if not thick enough to keep shell out, is worse than none. The Huascar's armor served only to explode the Chilian shell; those which struck the unarmored parts of the hull passed out without exploding and did little or no damage. This is a powerful reminder that the *mine*

power of the shell is the effective feature, and also shows that the thin armor which is now employed to keep out high explosives and secondary battery fire, will simply insure the explosion of shell from the main and auxiliary batteries.

The necessity of great mine power, the disadvantages of a very flat trajectory, and the general insufficiency of high-power rifles in attacking shore works, were brought out during the bombardment of Alexandria in July, 1882. The engagement lasted ten hours and a half, and the fleet threw 3198 projectiles, of which 1731 were of and above 7-inch calibre (at the end of which, by the way, their ammunition is said to have been nearly exhausted).

In a report on this action, made by Lieut.-Commander Goodrich, U. S. N., occurs the following: "Recent high-powered guns are not adapted to bombarding earthworks." This conclusion was based upon personal observation which led to the statement that, "To the unprejudiced observer, the most striking characteristics of the bombardment are without doubt the excessive apparent and slight real damage done to the fortifications."

The fleet was victorious in that the garrison was driven from the batteries and the forts were silenced; but the British Commander-in-Chief in his Order of Battle had said: "Finally, the object of attack is the destruction of the earthworks and dismantling of the batteries on the sea front of Alexandria." Regarding this, Commander Goodrich says, "The forts at Alexandria were badly bruised, but the more modern parapets were not seriously harmed. In the generality of cases, the real damage they sustained could have been easily repaired in a single night. If the bombardment was directed against the forts in this their defensive capacity, it must be pronounced a failure. If its object was the dismounting of the new rifled guns, it must be conceded that such results as attended the work of the inshore squadron (only one gun of this type being seriously affected), or even as were achieved by the offshore squadron (less than one-half being permanently disabled), do not justify the verdict of success."

This same officer goes on to remark: "If Admiral Seymour had possessed a vessel carrying both heavy modern high-powered guns and large howitzers, or other shell guns capable of great elevation and thus somewhat similar to the mortar in application, she would have been of immense value" . . . "The necessity of a thorough determination of the possibilities of vertical fire must be patent to

the most careless reader of this report. It is hardly an exaggeration to suggest that of all the directions open to the development of ordnance at the present time, this is by far the most promising and important."

These last remarks are of increased interest as an answer to a rather general and sometimes ill-considered outcry against curved fire from a floating platform. The pneumatic gun as installed on board ship is not easily capable of change of elevation; and for general service the angle of departure should not be greater than necessary to insure non-ricochet, say 18 degrees; but the corresponding angle of fall, say 25 degrees, will make the fire very searching behind parapets, while at the same time it would be more accurate than actual mortar firing in the strict acceptation of the term.

Commenting upon the need of curved fire at Alexandria, in O. N. I., General Information Series, No. VIII., Lieutenant Vreeland, U. S. N., says: "Had Admiral Seymour's fleet included a Vesuvius, that vessel could have placed herself behind any one of the huge armor-clads of the attacking squadron and from that position could have easily landed within the shore forts, at an angle of fall of about 25 degrees, projectiles filled with the enormous charge of 500 pounds of dynamite, the effect of which can be imagined. Conversely, had the shore works possessed one or more dynamite throwers, the attacking fleet would probably not have calmly delivered its fire from a 1600-yard range."

The result of the bombardment of Sfax by the French fleet in July, 1881, was equally disappointing. As remarked by Captain Clarke, R. E.: "At Sfax, after a remarkably deliberate fire of 2002 projectiles delivered under peace practice conditions, the defensive power of the place is reported to have been practically uninjured." The range here was much greater than at Alexandria.

To accentuate still farther the fact that the value of certain weapons is recognized in spite of occasional disappointment in actual results, allusion should be made to the attempt at Bucharest in December and January, 1885–86, to subject the Gruson cupola and the rival St. Chamond turret to a vertical fire from an 8¼-inch Krupp rifled mortar. Seventy shell were fired at the turret and ninety-four at the cupola, from a distance of 2760 yards. Not a hit was scored. This was not remarkable, considering the range and the smallness

of the target; but it was disappointing, as six or seven hits had been counted upon. The rectangles were in one case 394 yards in range by 273 laterally, and in the other case 273 by 76 yards. The concensus of professional opinion gathered there seemed to be that the accuracy was fair, and that due weight should be given to the following facts: The penetration of the steel shell weighing 200 lbs. was 13 feet into the tough soil of the Cotroceni proving ground; and the angles of fall were so great (57° to 61°) that the fire would be very searching. In view of these features it was considered demonstrated that if 200 shell were thrown against a fort of ordinary dimensions from a battery of mortars 2500 metres away, not a gun nor a man would escape if protected only by the parapet; and it was held that this trial fully justified the course of the Roumanian government in elaborating a scheme of turret forts around Bucharest as the only means of resisting attack by vertical fire.

It is interesting to note one more point in connection with those trials. It was decided later on to fire seven more shots from the mortar, and to load the shell in order to judge of their effect in case of still missing the target. There were still no hits. The shells weighed 200 lbs., including a bursting charge of 24 lbs. of powder, or 12 per cent. of the total weight. They penetrated about 13 feet into the ground, and their explosive force was not sufficient to properly upheave the weight of earth covering them. The propelling charge was only 6.6 lbs. of large-grain powder, or about one-thirtieth of the weight of the projectile; so the shock of discharge was probably as gentle as is practicable in a general service mortar; and the slight amount of explosive thrown, as compared with what is done with the gentle pneumatic discharge through a long bore, emphasizes the claims made in that direction by the friends of the air gun.

Some of the elements involved make a comparison quite fair between the practice effected at Bucharest and that of the 8-inch pneumatic gun in the Silliman trial in September, 1887, when projectiles weighing 137 lbs. carried 55 lbs. of gelatine and dynamite, or 40 per cent. Both firings were under proving ground conditions. The results at New York were superior, the second shot after the trial one injuring the schooner, the third sinking her by torpedo effect, and the fifth hitting the wreck. The target here

was larger than at Bucharest, and the range was only two-thirds as great; but the fifth shot scoring an actual hit argues gratifying accuracy. It is also true that this precision was obtained by using the air in a way which, as pointed out previously, could not be adopted in naval service; but this trial occurred very early in the history of pneumatic gunnery, in fact in its very infancy, and giant strides are made in the infancy of any weapon. In the light of subsequent work, there is little doubt that equal accuracy can be uniformly achieved now without resorting to mechanical methods which, though excellent in themselves, may be faulty from a tactical standpoint when applied to a floating gun.

Apart from actual hits, the object sought at Bucharest was a large angle of fall, which kept the projectile in the air and exposed to the effect of the wind longer than was the case in the less high angle firing at New York; on the other hand, there would be no possibility of injury by the mortar from flatness of trajectory under water, supposing its target to be a vessel. That feature of the pneumatic gun cannot be too strongly dwelt upon; if, in order to be effective, a shot need not strike within an exact small space, it is manifestly misleading to argue against its usefulness that it may be difficult to make it hit within that exact small space at sea.

Reciting these instances where the B. L. R. has proved to be not all-sufficient for the varying phases of modern warfare, is not intended as, nor does it constitute an argument against its superior value as an individual weapon. Through many generations the history of naval wars was but the history of the gun. In the great majority of engagements it has been the sole arbiter, bringing victory to those who used it with most skill. But as spheres of action enlarge, and more diversified results are required, our tools must likewise increase in number and variety. As the genius of the defense periodically overmatches the offense, the latter may be checked, but it quickly springs to the front and takes the lead again. If in one of these advances it produces a new weapon able to usefully supplement what already exists, it behooves us to look to it that an important auxiliary be not neglected.

The weapon which is sometimes accorded second place is the ram; it is the most unwieldly, but the most destructive in its effect. Its unwieldiness has been shown, no less than its power, in the unintentional encounters which punctuate the his-

tory of modern evolutionary practice. In considering the question of its use in war, we are confronted by the serious fact that its maximum range is zero, an almost prohibitory feature; as a matter of fact, there is not a case on record of an attack being successful unless rendered possible by accident or especially lucky circumstances skilfully taken advantage of by a plucky commander. At the same time its installation does not interfere with any other quality or function of a vessel, so it would be foolish not to strengthen and fashion the bows of all vessels in readiness for such a chance.

The ram may be said to have been ushered into the modern arena during the remarkable action off the Island of Lissa in 1866, where the tactics of the Austrians were simply "to rush at everything gray." At the outset, in line abreast, they charged the Italians in line ahead, Admiral Tegethoff's signal being to "rush against the enemy and sink him." But the gray column simply opened out (possibly unintentionally), and blinded by the smoke, the entire Austrian line rushed through the interval, not one of their ships even touching one of Admiral Persano's. The *mêlée* which ensued was a veritable tournament, the gun being apparently considered as only supplementary to the ram. The Don Juan, of Austria, and an Italian frigate singled each other out, and charged and countercharged repeatedly without result. The Kaiser, an unarmored wooden line-of-battle-ship, escaped from four Italians, and, when threatened by the Re di Portogallo, rushed at her and struck a glancing blow which resulted in her losing her bowsprit, foremast and smokestack, and sustaining such other injuries as to have to haul out of action. The Habsbourg charged several Italians in succession, but they all eluded her. The Affondatore, the only Italian with a ram bow, had the opportunity of sinking the Kaiser early in the day, but it is said that her captain had not the nerve, and, putting his helm over, refused to deliver the blow; plucking up courage, however, after that, he tried to ram the Ferdinand Max, which vessel manœuvred to strike him instead, and the two almost touched in rushing by. The Re d'Italia made two unsuccessful attacks, and was apparently just gathering headway for a third when overtaken by fate; a midshipman in the foretop of the Ferdinand Max had suddenly recognized her through the smoke, lying nearly motionless and broadside-to right ahead; and

starting ahead at full speed on her fourth ramming attack, the Austrian flagship made up for previous ill success by striking the unfortunate Italian on the port side with a speed of 11 knots. The victim lurched heavily to starboard, rolled back to port, and sank with her crew.

This fearful consummation had an important influence in determining the subsequent building programmes of Austria and of some other countries. But, while recognizing the completeness of the one success, it remains a significant matter of wonder that but the one fatal blow was given in the dire confusion of such a hand-to-hand fight. It is surprising also that the only instance of collision between friendly vessels occurred when the Ancona and Varese went to the assistance of the Re di Portogallo; thanks to glancing blows and straight stems, no great harm was done.

Since then the rounded stem of the Ferdinand Max has been replaced by the projecting spur, and in almost all duels or general engagements the foremost idea has been apparently to ram. The Huascar failed twice with the Esmeralda, in May, 1879, although the latter's speed was reduced to about three knots by the disabling of two of her boilers; finally, the Esmeralda's rudder being carried away, a third attempt succeeded. The fact of an ironclad resorting to such tactics when engaged with an unarmored vessel so greatly inferior in size and power, can only show that the former despaired of accomplishing any serious result with her artillery alone.

There have been no other important instances of success, but many of failure. Even the Almirante Cochrane and Blanco Encalada failed in their five attempts when the Huascar's steering gear was crippled and her speed greatly reduced. Yet the great difficulty of consummating a ramming attack does not diminish the eagerness with which the possibility is kept in mind; and the fear of it imposes rigid conditions in the handling of both squadrons and single vessels.

It is much the same with the automobile torpedo, aptly termed by M. Gougeard, "a master-piece of clockwork applied to the art of destruction;" an instinctive appreciation of the tremendous value of one hit compels its retention on board. Many who affect to despise the torpedo, speak of its moral effect as its principal quality; it may be observed that if it does have a moral effect

among the hardheaded men who fight the ships of the present day, it must be because a very positive material effect is recognized as backing the moral one. The certainty of this has been heightened by the sinking of the Blanco Encalada in Caldera Bay, in April, 1891. The unvarnished fact that 110 pounds of gun-cotton blew a hole about 21 feet by 10 in the bottom of that armor-clad, causing her to sink in five minutes with a large part of her crew, constitutes an object lesson not soon forgotten, and which doubtless the captain of every torpedo-boat hopes to profit by and repeat.

In a dispassionate study of weapons, however, the naval officer must recognize the fact that the feat was rendered possible only by an inertness and negligence on the part of the defense difficult to conceive. The two attacking vessels, of 750 tons, approached on a calm, moonlight night, and discharged five torpedoes from distances of 100 yards and less, the last one alone reaching home, the Blanco lying unprotected by nets, booms, search-lights or picket boats. It might perhaps be safe to say that such conditions would never arise again, but for the recollection of the somewhat similar occurrences at Sheipou, in February, 1885. At all events, the mere possibility of achieving such a result will prevent the abandonment of that type of vessel, whether it move at or below the surface, and whether its armament be adapted for striking through the water or through the air.

With regard to their installation in large vessels, it is pertinent to remark that if torpedoes had existed in their present state of development in 1866, the Austrian fleet would perhaps not have borne down so fearlessly on the Italian column off Lissa. If it had, friends as well as enemies might have suffered.

Apart from the immediate material results hoped for from a lucky shot, the usefulness of the torpedo is great in that it leads to the enemy being hampered in his movements by a cumbersome steel net, imposes the obligation of his maintaining a large and costly fleet of marine skirmishers, and compels a state of ceaseless vigilance and preparation such that it may prove as necessary for blockading ships to go off and rest as for them to go for coal and oil. This vigilance and the number and power of torpedo-boats must be if anything increased when the enemy is known to have vessels of about the size of the Condell and the Lynch, fitted to throw 500-pounds charges 1400 yards, or 200-pounds charges

2200 yards, at the rate of one a minute, and against which steel nets are of little or no avail.

The considerations which suggest and also spring from this hasty glance at the modified success attending the use of the three long known weapons, gun, ram and torpedo, lead one to realize that the pneumatic gun in its hitherto short career has achieved a success comparatively disproportionate to the opportunity it has had for development; and a practical study of the mere mechanical problems involved has impressed upon those who have had to do with them the certainty that in this, as in all other weapons, increased perfection will be the inevitable outcome of experiment. The matter seems to resolve itself into the question—does the end justify the means?

Reverting to the statement of the first Naval Board that the pneumatic gun cannot replace any existing weapon nor be replaced by any, we find that that may be supplemented by another statement,—that it is the only weapon which may be used indifferently for either above-water or under-water attack, a pre-determination of which is intended not being necessary. General Abbott, in introducing the subject of mortars and submarine mines, in his "Defense of the Sea Coast of the United States," says: "These modes of counter attack directly assail what is now and what must continue to be the most vulnerable parts of a ship—her deck and her bottom." It is clear that the pneumatic gun, to a certain extent, combines those useful functions. It can attack the bottom of an armor-clad whose vitals are invulnerable above water; the B. L. R. cannot. It can attack the upper works, battery and crew of a vessel; the torpedo cannot. With it, the same vessel and crew which may attack a battleship, or bombard a fort or town, or clear a beach for landing, may in turn countermine a mine field, and do it in less time and with less danger to the countermining party than by any other method hitherto advanced.

These capabilities endow it unquestionably with a considerable military value, and the only argument which can be advanced against its more extended use afloat is the possibility of another weapon appearing, capable of doing its work as well. Will such a weapon appear? The nearest apparent approach seems to be in the shape of the low-power rifled mortar, such as is suggested for the above-water armament of Commander Folger's proposed

torpedo ram. It is difficult to contrast an incompletely known, and possibly not wholly complete design, with a finished product which has successfully withstood the fire of much adverse criticism; and as that ram will evidently be very much larger than the Vesuvius, an actual comparison of their individual offensive powers would be futile; but some of the inherently differing characteristics of their armament may properly be touched upon.

The details of the mortars have not been published, and it can only be surmised from the tenor of the Annual Report of the Chief of Bureau (1892), that the explosive contemplated is emmensite. This suggests the remark that the pneumatic gun is not necessarily tied down to gun-cotton; in its early days it received the unfortunate name of "dynamite gun," in consequence of the large quantities of that detonant thrown by it. It is not probable that dynamite will ever be allowed on board of a man-of-war, but it is far from improbable that camphorated gelatine, from its stability, insensitiveness, plastic nature and destructive energy, may prove a reliable and desirable substitute for gun-cotton, for storage on board ship and for use in pneumatic gun projectiles or movable torpedoes. Its specific gravity, like that of emmensite, being greater than that of gun-cotton, the proportion of weight of such a charge to that of the containing shell will be increased. As between the two, the specific gravity of the gelatine is about 1.54, and that of emmensite about 1.80; but the intensity of action of the former appears to be about one and a half times that of the latter, and it is therefore the more efficient of the two even when compared by volume. It is possible that these apparent ratios may be modified by the separate methods of loading, so that the loading densities may be found to compare differently from the gravimetric.

Whatever be intended for the mortar, the shell will be quite long, as the walls will have to have a considerable thickness to stand not only the longitudinal stress due to the shock of discharge, but also that of taking the rifling; and as the travel in the bore will not greatly exceed the length of the projectile, if at all, the entire discharge will be completed through a short space, and therefore will be quite violent even for a comparatively low I. V.

As the propelling charge of powder cannot conveniently be varied, the range will be varied by changes of elevation; and, as the term "mortar" cannot contemplate an even moderately flat

trajectory, the elevation will be considerable for ordinary ranges, and it will be open to the same reproaches as the pneumatic gun: that a knowledge of the range is necessary, and that the aim is affected by rolling. Coupled with this, there will be lacking the important feature of torpedo action and the concomitant increase of danger space due to the under-water run. This ensues from the certainty of ricochet if the angle of departure be less than 18° or 20°. To that extent, therefore, the mortar appears under a disadvantage as compared with the guns of the Vesuvius.

It is possible that the mortars may have a greater range than 2100 or 2200 yards, but that is not certain as the advantages gained would hardly compensate for the increased strength and weight of shell thereby imposed,—unless the increase of range be obtained by actual *vertical* fire. However valid the objection of short range may be for a land gun, no firing from a greater distance than 2000 yards can ever amount to much at sea. Any one who will note the size of target presented by a vessel more than a mile away will realize how natural it is that the fighting ranges are invariably so much less. Battles on the open sea have not been and will not be fought at such excessive distances; and to attempt it would be a mere waste of precious ammunition. With a town or dockyard or large fort for a target, a long range might at times be useful.

It should be remembered in this connection, as explained before, that the maximum range of the pneumatic gun is not obtained under the conditions usually accompanying a supreme effort and rendering a fair duplication doubtful. The greatest longitudinal accuracy is coincident with the greatest range.

In the mortar there is effected a saving of weight, and a saving of mechanical appliances and attachments requiring care—pipes, joints, valves, pumps, etc. The former is a tangible and important matter, the weight of the guns, reservoirs, air compressors, and motors aggregating to a high figure in the Vesuvius. Since her keel was laid, however, the advance in the mechanical arts has effected a great reduction in the weight of compressors and reservoirs. A possible and very important further advance in this direction would result from the discovery or practical application of some method of compressing air for storage by means of small, rapidly succeeding explosions. It has occured to me that the

principle embodied in the Maxim air gun could be applied to this purpose, or the powder impulse at present used for the Howell torpedo. This would save the weight and space absorbed by the air compressors, and the coal and oil required for running them.

As regards the amount of piping, joints, etc., to be kept in order and tight under pressure, that feature does not exist to any materially greater degree than in the hydraulic apparatus connected with turret mounts, and it is therefore quite admissible. As a matter of fact, a leaky air joint has been of rare occurrence during a three years' cruise. So far as vulnerability is concerned, all that gear, as well as the breech mechanisms, is below the water line and under a 1-inch steel deflective deck. The crew likewise are below and similarly protected. In the mortar vessel, the men and the loading gear required to handle shell of that size and weight, unless heavily shielded, remain exposed to the enemy's fire.

Of course, the published criticism of the Vesuvius, that disastrous results would ensue from the entry of a shell in her store of explosives, applies with precisely equal force to this proposed vessel.

While lauding, then, the value of an important design coming from so eminent source,* and assuming that all anticipations will be realized in execution, including an accuracy of fire equal to that of the pneumatic gun, it still does not appear that quite the same extended results are promised as are achieved by the Vesuvius. When the vessel is built and her armament tried, will, of course, be a better time to institute comparisons. But there is this to be said about it: If it is on the cards that a powder gun will be brought out capable of doing what is now done with the pneumatic discharge, that gun will not appear in the shape of a mortar; it must be a long gun, with a travel of 40 to 50 calibres. As has been remarked above, increasing the pressure in the pneumatic gun does not very greatly increase the range, because of the weight of air which has to be moved; this does not obtain with

* The laudation has reference only to that part of her armament which has been touched upon as bearing comparison with the offensive power of a pneumatic gun vessel. The proposition to carry two percussion shell, each containing 500 pounds of some detonant, right behind the spur of a vessel designed especially for ramming, is open to discussion, as a missfire or a lack of opportunity or failure from any cause to get rid of them before ploughing possibly into a heavy armor belt, might be attended with terrible suicidal results.

the powder impulse, and therefore a pressure twice or three times as great is indicated as proper for such gun. Difficulty in manufacturing a powder to give uniform results coupled with very slow action at such low pressures may, however, raise this to 5000 pounds.

The ideal sought after is a means of producing a low and constant pressure throughout, so that the final may be practically the same as the initial. In the guns of the Vesuvius, the final pressure for a range of a mile is about 100 pounds per square inch less than the initial. If a powder can be made to do approximately this with such certainty that a surplus strength is not necessary to protect gun and shell against possible abnormal stresses, then there will be effected an increase of range and a decrease of weights; on the other hand, the attack will be confined to objects above water, a limitation which is serious now and likely to become more so. If by alloying steel with nickel and hardening the surface by the Harvey process, we can increase the resisting power of thin armor to such an extent as to materially increase the area protected without adding to the weight, the attack by non-penetrating detonants will be proportionately handicapped, and it will be doubly important to increase the available target by the amount of the hull below the waterline. As, to accomplish this, a less elevation than about 18 degrees is inadmissible, and as a much greater angle is equally so, it follows that the pneumatic discharge will alone meet the requirement, for the reason that by no other means (known to me now) can the range be varied accurately without departing from those superior and inferior limits of elevation.

The wisdom of waiting indefinitely for a hoped for development is questionable in this as in many other things. While not germane to the subject in hand, an analogy may be found in the patient way in which we have been following an *ignis fatuus*, hoping against hope that some method would be discovered to prevent steel bottoms from fouling and rusting; after spending large annual sums of money in docking and increased coal bills, we are apparently about to accept the situation at last, and consider the propriety of coppering our cruising vessels, following where we should have led. The lesson may be useful.

If another pneumatic gun vessel be decided upon, it will be

possible and desirable to introduce several improvements in the design. The question of weights, always a perplexing one, was the more so in the Vesuvius from the large proportion absorbed by ordnance, it being no less than 16 per cent. of the displacement. This required a corresponding decrease in the amounts allowed to other departments, and in order to attain the required speed with the I. H. P. possible on the available weight, all other considerations had to be slighted It may be bluntly stated that had the Vesuvius been designed for less speed she would be a much more efficient and formidable vessel.

With the constant progress that is going on in types and details of vessels and machinery, it is probable that a vessel of about the same size and of greater speed may be produced associated with marked improvement in tactical qualities. Still, when the construction of another such vessel was provided for, in the event of the Vesuvius accomplishing useful results, it is, perhaps, to be regretted that the cast-iron requirement of 21 knots' speed was inserted, leaving no discretion to those who, with the exercise of sound professional judgment, might (I do not say would) find good reason to be satisfied with 18 or 20 knots if other more important features could be then secured. It so happened, unfortunately perhaps, that on the acceptance trial the Vesuvius recorded 21.66 knots for a short run; and it seems apparent that that accident led to the severer requirement for the next vessel, although the Vesuvius can only be regarded as a 20-knot vessel for any material length of time (and certainly not that except with a clean bottom and smooth water); and to insure a higher speed might require the sacrifice of certain qualities still more vital in action.

A better understanding of the tactical requirements of a pneumatic gun vessel now points to the necessity of having one gun aft (unless the vessel be a double-ender as suggested farther on). This will call for two loading rooms and magazines, as each muzzle should be as near as can possibly be managed to its own end of the vessel; it will not waste much room, and other conditions arising from this feature can be met by placing the groups of firing reservoirs under the engines and boilers, extending from one loading room to the other. The plan is worthy of consideration, of laying one of the bow guns nearly horizontal, so as to give it a flat trajectory and insure a hit within the proportionately short-

ened range. This has some commendable points, one being that the gun thus installed would be available for work under circumstances unfavorable for distance determination; but apart from its being thus crippled in range, it would really become a different weapon, losing its faculty of striking below the surface; and the entire gun, breech mechanism, crew and all would be brought up into an exposed position above the waterline.

Each gun must be capable of being isolated by an efficient stop valve (to serve also as a throttle), between which and the gun there should be air capacity not exceeding one half of one per cent. of the total capacity of the firing reservoir. The hydraulic pump for opening and closing the breech, revolving the ammunition racks and operating the rammer should be replaced by manual gear or possibly electric motors. The fighting tower will naturally go where it can have an unobstructed view ahead and astern between the two smokestacks (disposed athwartships) and over the gun muzzles, with firing levers for all the guns, and sights for both fields of fire; it should be three inches thick, or as nearly that as possible.

The proportion of length to beam should be less extreme than in the Vesuvius, for the purpose of increasing the turning power, steadiness of gun platform, and length of base line for the range-finder. The transverse metacentric height of the Vesuvius is more than ample, and could be reduced with beneficial effect on the rolling. There should be no external middle bar keel, but two bilge keels; the rudder should be larger, and the shafts as nearly parallel as possible. The bow must be strong for ramming, and carry a slightly protruding, somewhat flattened circular punch under water.

The great advantage that would be gained if it were possible to advance when the enemy retreats, and retreat when he advances, while still keeping him uninterruptedly under the guns at an approximately constant range, suggests the plan of having twin screws forward as well as aft, those on each side being on a common shaft, and of having a rudder at each end capable of being rigidly and solidly locked. By this means alone can equal speed and equal control be effected in going at will ahead or astern. The increase of weight, however, and the lack of available space would probably make this arrangement impossible in a vessel of

the proposed size and speed. If attempted, it would of course do away with any idea of using the vessel as a ram, unless self destruction were accepted in advance; but that should not stand in the way for one moment; the remote possibility of a successful ramming attack cannot be mentioned in the same breath with the great tactical superiority that would result from the freedom of movement in either direction. Incidentally this way of applying the motive power would permit a reduction in the diameter of the screws, which would be a good thing for some reasons, and would insure the shafts being parallel. The necessity of having a gun pointing astern would also be less great, although in many phases of battle, especially in a general engagement, it might still be very useful.

As the essential *raison d'être* of the pneumatic gun vessel is to attack large ships, and as the main defense of those ships will lie in the number and power of their torpedo-boats, it is desirable that the vessel should be able to stand up against a reasonable attack of that kind while delivering her fire at the ships. To this end there should be at least one inch of inclined armor over the machinery and loading-rooms, and a secondary battery of as many high-power one-pounders as can be located, and for which crews and ammunition can be carried. With good coal the Vesuvius can steam about 3000 miles, and that radius of action should not be reduced if it is possible to avoid doing so; but if the weight of protective deck and ammunition and space for the crew should compel a reduction to even 2000 miles, it should be allowed rather than tamper with the battery. There is no use in being able to go fast and far if you cannot do anything when you get there. In case of starting out on an expedition in distant waters, about 20 miles will be added to the endurance for every ton of coal carried on deck. A vessel of this kind is not a cruiser and cannot be made one; any attempt, therefore, to find room for a large supply of coal [illegible] would be out of place.

With the general features indicated above, it will remain for the naval constructors to accomplish the design on as small a displacement as possible. The plan is not advanced as the one positively best devised to serve as the carriage for the pneumatic gun afloat, but as the best that can be done to produce the character of vessel contemplated by the appropriating act, in case it should be decided to

use that money. Whether the maximum efficiency can be obtained in a vessel of this size or in a vessel heavy enough to secure greater steadiness of gun platform, and to afford train, elevation, and possibly armor protection to the tubes, is not to be answered off-hand; but it seems clear that, on account of the space required, in vessels up to 2500 or 3000 tons the pneumatic gun if installed at all should constitute the principal weapon, supplemented by the ram and a heavy battery of 14-pounders and 1-pounders. If any larger guns are mounted they should be of considerably larger bore, but of light weight and low power.

If mounted in torpedo-boats in the present acceptation of the term, that is to say, in vessels up to 150 or 200 tons displacement, the air pumping should be done on shore, and the boat "aired" just as she would be coaled, watered and provisioned; then all that would be needed on board would be a small compressor such as the Cushing carries, for making up leakage. This would require that we introduce some semblance of order and system in any supposed scheme of coast defense, the idea being that one or more of these boats would be apportioned to each important stretch of coast, with headquarters at a central port of that stretch.

In battleships, harbor defense monitors, etc., the pneumatic gun will be subordinated to the B. L. R. The latter, by reason of its handiness, accuracy, power, safety and extended sphere of general usefulness, will undoubtedly continue to commend itself for the first place in war. But it cannot, alone, meet *every* requirement; it needs to be supplemented.

Among the various auxiliaries which have their own separate and individual functions, the guns of the Vesuvius have at present a reasonable service accuracy, and are efficient in range and adaptability to ordinary conditions; it is certain, also, that from the experience already gained, their reliability in point of accuracy can be increased without great trouble or expense, and their adaptability and serviceableness greatly enhanced by installation in a properly designed vessel. Furthermore, when effective at all, they will be so to a very high degree, as was the ram of the Ferdinand Max at Lissa, or the torpedo of the Lynch in Caldera Bay; and they will, therefore, assert themselves as productive of both material and moral effects which no tactician can afford to neglect.

DISCUSSION.

Lieut.-Commander FRANK COURTIS, U. S. N.:—I have read with pleasure the advance copy of Lieut.-Commander Schroeder's able article on this vessel and the pneumatic gun system. I agree with all that he says in regard to both vessel and pneumatic system. I am not prepared to discuss the matter to any extent for the reason that I have had no practice, as we have had no projectiles on board, and the Navy Department is stopping all experiments for the present. The system is kept in perfect order and is available for use at any time.

I have been much impressed with the fact that all the officers that were on duty on this vessel during the trials are most enthusiastic and believe thoroughly in the system; they are officers of great ability, and are perfectly familiar with the workings of all the various parts and functions of the system. They do not claim that it is by any means perfect in its present form, but hold that it has great merit, and is susceptible of being developed into a most useful arm; this can only be done by continued experiment, and the expenditure of considerable money, just the same as has been the case with the high-power gun, which has only reached its present stage of perfection after years of experiment and at great cost. The history of the automobile torpedo is also an example of this; if it had been given no more encouragement than the pneumatic gun has received up to this time, it would have been abandoned long ago.

In my opinion, the greatest drawback to the system has been the lack of a proper fuse; this is, in reality, a simple matter, and one that will be soon remedied if it has not already been done.

A great mistake was made in calling this system a dynamite gun or even a pneumatic gun; it should have been called an aërial torpedo-tube or ejector. I consider that the projectile is as much a torpedo as the Whitehead or Howell, and it is by no means certain that this same system could not be used as launching-tubes for these very same torpedoes.

It seems to me that it would be a very poor policy for the Navy Department thus early to abandon, without further experiments, this system.

Lieutenant G. C. HANUS, U. S. N.:—Having carefully read over the paper, it seems to me that the pneumatic battery has been so ably, thoroughly and fairly discussed by the author, that it is almost impossible to find anything to criticise, if, as in my case, one has been associated with the pneumatic system as installed in the Vesuvius, and has witnessed the development and rapid progress in a positive knowledge of the workings of the system attained during the trials at Port Royal. When it is remembered how much time and intelligent labor has been consumed in the

development of the Howell torpedo, and how much experimental work has been done in the perfection of all torpedoes, it would seem a miracle if the system on the Vesuvius had been perfect in every respect. Nevertheless, at a distance from 1500 to 2000 yards, the accuracy of fire was remarkable, especially with the middle gun, in which the design of the main valve was altered, as stated by the author, and if some means be taken to pump up the reservoirs, so as to exclude moisture, which can be done practically in several ways, there is no question, judging from actual experience, that the same result will be obtained with the same loss of air; in other words, that a uniformity of action can be obtained. The perfection of the system is only a question of time, and many officers are willing to concede that it may be of great value on shore, but doubt its effectiveness when the platform is unstable, as on board ship. While those best acquainted with the system would not be willing to concede this, it must be apparent to all that there would be a great advantage in having a movable platform, such as an improved Vesuvius, which could be used to great advantage in the attack or defense of harbors or in smooth water. It is to be regretted that experiments to show the actual destructive effect of the detonation of two hundred pounds of gun-cotton on the deck of a ship leaves the result somewhat a matter of conjecture, but it is generally supposed that the boilers would explode and that much of the machinery would be broken, outside of all other damage that might result. The possibility of the terribly destructive effects of the vessels of this type would naturally have a demoralizing effect on any enemy; the great danger from undervaluing the system comes from expecting perfection, without development based on actual experimental work. It must not be forgotten that, after a most exhaustive trial by the board at Port Royal, they said in their report of the system that it is of decided value in naval warfare. While the failure of the Rapieff fuse on the trial may not in itself appear as very important, there is no doubt that it had a bad effect, many persons not being aware that shell had been fired and properly detonated from each tube or gun at the acceptance trial of the vessel with another fuse.

Lieutenant H. M. DOMBAUGH, U. S. N.:—While the subject of the Vesuvius and her guns is under discussion, I wish to add my endorsement to all that Lieut.-Commander Schroeder has said in his paper. He has left nothing to add on the theoretical side, but a few remarks on the practical side of the question may not be amiss. The first difficulty with the guns of the Vesuvius was their installation on board before the system was practically developed, and from this all the other troubles emanated. The inception of the idea of a vessel with guns capable of throwing large quantities of high explosive fired the mind of the public, and the result was the Vesuvius. Since the acceptance of that vessel, great improvements have been made in the mechanism for controlling the air. Some of these have been supplied to the Vesuvius and showed their superior working on the last trial.

The few remaining difficulties are of a mechanical nature and are capable of being made practically perfect. The presence of moisture in the compressed air, the quality of the material from which the seats and buffers of the valves are made and which is affected by that moisture, are all capable of being guarded against or improved. The fuse has already been developed (since the last trial in 1893) and practically tested on the Nictheroy. A correspondent on board that vessel, writing under date of March 15, 1894, says: "Captain Baker and the other officers speak in enthusiastic terms of the trial of the cruiser's famous dynamite gun; just before entering the harbor on the day of the surrender of the rebel forces, a shell was fired at Pai Island in the bay, and all agree that the explosion was 'fine'."

The trials which are to come off at Sandy Hook in the near future may be looked forward to with great interest, and the value of the system will be settled one way or the other.

Between compressed air and powder as propelling agents of the high explosive shell, I believe the former to be capable of greater control than the latter, and to answer better to the demands of the service in giving a more rapid change of range.

Lieutenant ALBERT A. ACKERMAN, U. S. N. :—I had excellent opportunities during the trials of the Vesuvius at Port Royal in 1893, to observe the accuracy, angle of fall, and under-water range of her projectiles, and willingly express my belief that the vexatious difficulties encountered within the limits of the practice were purely mechanical and possible to overcome. The Vesuvius should not be regarded as representing the present development of the pneumatic gun afloat. As indicated in the essay, many improvements, suggested by the experience of her late commander, can easily be made; others, more important and radical, would require a new installation, if not a new vessel. There is little doubt that, in a second Vesuvius, all that the essayist claims for a perfect vessel of this description could be obtained; except, perhaps, accuracy for ranges under five hundred yards, where the superiority of the automobile torpedo is unquestionable through being self-propelled and independent of errors in elevation and range.

There are strong doubts, however, as to the usefulness of such a vessel, and in this connection, the first few paragraphs of Lieutenant-Commander Schroeder's essay are most significant. The attempt to compress the still nebulous art of naval warfare into the narrow bounds of a single theory, however ingenious, cannot succeed. It failed with the Alabamas, the monitors, the rams, and the torpedo-boats, and so it will with other devices yet to be imagined, leaving them, at best, if utilized, subservient to the gun as an adjunct of the battleship.

It may be said that the Vesuvius was not intended as a cheap substitute for the battleship, but if not, what was her mission? It was proposed to

defy gun-fire in order to destroy powerful ships with one blow; to countermine harbors; bombard forts and cities;—all of which is the proper work of battleships. At the same time, to ease the comparison, the principal weapons of the battleship,—the gun, ram, and automobile torpedo, are criticised. The torpedo is kept for moral effect and a lucky chance; upon the latter the ram must also depend; the pneumatic gun could have annihilated the Huascar when modern B. L. R's on armored vessels failed. In passing, a better instance of the defenselessness of slow monitors, compared with the aggressive strength of many-gunned battleships, could hardly be made,—but our coasts will not be attacked by superannuated monitors.

The essayist states that, in considering a new weapon, one must be careful not to impose conditions too severe, nor expect results too great. Inventors invariably set the pace themselves, boards are appointed to report upon merits claimed, and incidentally on the accompanying disadvantages. Numberless suggestions and inventions are pressed upon the authorities. To make anything out of the best of these requires large expenditures, constant modification, and time for patient investigation and development. It is needless to say that the energy and money thus expended on novelties is often a direct loss if not menace to the growth of a new and efficient navy. The methods of promoters in the daily affairs of life are doubtless properly valued by our legislators. When applied to undeveloped weapons of war, however, there is a natural apprehension among those long acquainted with the profession and its needs, lest that which is now serviceable, through development, be laid aside in favor of a crude idea with its supposed possibilities. There should be a spirit of most cautious conservatism in dealing with such matters if it can be exhibited without discouraging invention.

In the development of our navy, not a step has been taken nor a good feature established,—from the selection of steel for ships and guns to the adoption of Harvey armor,—that has not met with resistance. The way through which our battleships have thus far progressed is strewn with the wrecks of theories and inventions, each offering its own delay and diversion, all more or less serious obstacles. If anything has prevailed, it has done so on account of its good qualities and in spite of its defects. In this struggle, the pneumatic torpedo-gun afloat must take its chances with the rest.

To consider the advantages claimed for a perfected Vesuvius:

It is just as fair to suppose a pneumatic gun mounted in some of the fortifications at Alexandria as it is to imagine one in the bombarding fleet with a battleship as a shield. In such a duel the advantage would be all in favor of the shore gun. Wide bases would put its crew in possession of the cruiser's range far more accurately and quickly than it could be obtained on the latter, which would also offer a larger and more vulnerable target. Injury to the vessel would disable her gun; while the one on

shore, to suffer seriously, must be in the immediate vicinity of the explosion; at the same time it might be shielded by earthworks or armor. The battleship would certainly retire to a safe range under the circumstances, leaving the cruiser to follow as soon as disclosed to the shore guns. The value of the Vesuvius in this case depends almost entirely upon the invulnerability of the battleship selected for its shield, as well as the more or less doubtful probability of there being a shore pneumatic gun or dirigible torpedo convenient to the point selected for attack.

The efficiency of the dynamite-gun for countermining is unquestioned, as far as it goes. The point is, in opening up a mined harbor, could a sufficient number of projectiles be exploded with such precision as to justify the commander of the blockading forces in the belief that he had a clear way in, or would it not, after all, be necessary, before advancing, to use slower, less expensive, and more certain means. It must be remembered that the preponderance of the Union Navy during the Civil War was so great that no hesitation was shown in sacrificing ships to gain ports. Do we hold this position now towards any possible adversary?

The essayist regrets that so much in the Vesuvius has been sacrificed to speed, and yet, from the nature of her weapon, she is at the mercy of any opponent, be it gunboat or battleship, possessing greater speed and able to keep out of range. It has become a habit to charge to this "craze for speed" all the defects of a general design, which, without high speed, would not have served its purpose. Fighting ships are far more serviceable than commerce destroyers, and to get them on little more than the same displacement, speed must be sacrificed, but then they would cease to be commerce destroyers. We must not decry the cruisers' speed, for it is nearly all they have.

No slow-moving vessel without long-range weapons can hope for victory in a duel with any other than a similar opponent. The shorter the range of weapons the greater the necessity for speed, handiness, and protection. To obtain these, even while making sacrifices in all other directions, implies a large increase of displacement and cost.

Any weapon depending upon the helm for pointing, be it gun, ram or torpedo, is at a serious disadvantage. If, in addition, its range is limited, occasions for its use will be rare and of short duration, even when sought in a general engagement. When in a more or less complete battleship it is determined to utilize such a weapon, every other means of offense must be subordinated to it in a way that for the time seriously impairs, if it does not destroy, their value. Vulnerable points are exposed and more vulnerable resources are neglected,—all for the uncertain chance of destroying the enemy with a single blow. Battles may often be won by chance hits, but the commander is unfortunate who has to rely upon them to win. In the case of a vessel depending upon a single class of weapons of this limited description, it must either be the aggressor or run away. It has no real defense, and its opponent, taking the offensive or defensive at will,

is always able to forestall its intentions, knowing when and where they must culminate in attack. Such vessels cannot fight in the line of battle, nor in squadron, as the necessary evolutions would still more restrict their usefulness. If they fight independently in a general engagement, their peculiar weaknesses, combined with the number and position of the opposing guns, would lead to their speedy destruction. In fact, no vessel should be entirely dependent upon such a weapon, and its use, when employed at all, should be relegated to the chances which may or may not appear in the varying positions of a gunnery engagement. In this connection, however, I might call attention to the serious disadvantage under which vessels are placed, especially of the class under discussion, when they carry a set of ranges in the shape of widely separated masts or smokestacks. The slightest change of course is at once indicated to the skillful opponent who is quick to turn it to his advantage. In no better way, also, can the location of gun and torpedo-ports be indicated to the rapid-fire crews of the enemy under many conditions of battle.

There is but one more case to consider, that of a slower gun-vessel being overtaken by the Vesuvius. The latter has the choice of position, with the certainty that she will be exposed to fire before her maximum range of 2000 yards is attained. Suppose the Vesuvius, going 18 knots, to sight a battleship going 12 knots and able, like the "Royal Sovereign" class, to turn 180° in 3.25 minutes. The battleship would open fire at over 3000 yards range, she would also drop a few pairs of yoked torpedoes and might experiment with others out of her stern tube. Let these be diverted, the pneumatic-gun-vessel escaping their snares as well as damage from the enemy's stern or quarter fire. When still 2900 yards away, the battleship puts her helm over and, turning rapidly, changes both direction and distance by varying amounts each successive instant. These changes must be very puzzling on the Vesuvius where the correct range and direction 12 seconds after discharge must be known before that discharge; they are also at their maximum about the time she reaches her chosen range of 2000 yards. At the same time all of the broadside guns of the battleship are bearing and the chances of that vessel being hit, even were she stationary, is but 65 per cent. of what it would be were she end on. If the guns' crews of the battleship have been trained on rams and torpedo-boats, the Vesuvius may escape, but if they have been brought up at their guns, the issue is not doubtful. The Vesuvius must either slow down in time and run a greater chance of being hit, or fire a salvo at varied ranges, meanwhile rushing on to nearer and less accurate firing-points, then turn, exposing her broadside, in order to run off and prepare for another onslaught.

The energy and skill with which Lieutenant-Commander Schroeder carried out his difficult duties on the Vesuvius have been commended by those far better able to judge than the writer; they certainly merited and would have attained success had that been possible. Their failure, however, lies

not in the unsuccessful development of the weapon, but in the principle that the pneumatic torpedo-gun as mounted in the Vesuvius is not of as great general value as desired.

Professor P. R. ALGER, U. S. N.:—Lieut.-Commander Schroeder's argument as to the comparative ineffectiveness of the modern gun would be less convincing were all the facts set forth. Taking Lieut. Mason's report as authority, I find that, although the action between the Huascar and the Cochrane and Blanco Encalada lasted ninety minutes, the Blanco was not engaged during the first forty-five minutes of this time. Moreover, the firing, instead of being at ranges from 500 to 5 yards, opened at 3000 yards, and one of the Cochrane's first shots, at about 2000 yards range, penetrated the Huascar's side armor and, exploding, entered the turret chamber, killed and wounded twelve men, set fire to the wood-work, and jammed the turret. During the action, eighty men out of a crew of about two hundred were killed or wounded on the Huascar, and twice the turret was pierced and both the guns' crews destroyed. Altogether, it seems that a more striking proof of the terrible effectiveness of the modern gun than this engagement could not well be found.

On the other hand, the effect of the dynamite guns of the Vesuvius, under similar circumstances, judged from their latest performance, would have been absolutely *nil*, for not a single explosion was obtained from the twenty-one service projectiles fired by the board.

I trust that the author's statement that we are considering the propriety of coppering our cruising vessels may prove unfounded, as this backward step would be even less justifiable than the use of compressed air in place of gunpowder as a propellant. Continued "progress" on the same lines would take us back to the wooden ship and the catapult.

The statement that, had the Vesuvius been designed for less speed, she would be a much more efficient and formidable vessel may, in my opinion, be applied with still greater truth to almost all our recent naval constructions, in which the most valuable qualities are sacrificed to an insane desire to achieve a high speed.

Lieutenant WM. F. FULLAM, U. S. N.:—The essayist has discussed the subject of the pneumatic gun so thoroughly that little remains to be said either in favor, or in criticism, of the system. No extravagant claims are made, and the limitations of the weapon are frankly stated. It is demonstrated that this gun is an important auxiliary, and that, in a certain field, it has no competitors and cannot be replaced by the torpedo or the high-powered rifle.

In the many varying conditions of naval attack and defense, it is quite reasonable to suppose that other weapons than "the gun, the ram, and the torpedo" may be necessary for the successful and speedy accomplishment of a certain purpose. To be sure, it would not be wise to accept the wild-

cat schemes of every enthusiastic inventor and fill the service with a great variety of weapons of restricted usefulness. But it is certainly important that the minds controlling the armament of a navy should be broad-gauged enough to recognize a valuable innovation.

The defects in the Vesuvius as a ship should not militate against the pneumatic gun. She was not built with a very well-considered view to the proper utilization of the power of her guns. She appears to be one of the saddest results of the craze for *speed* that has taken possession of us in recent years. Newspaper headlines have declared in flaming capitals that nearly every ship built for the "new navy" is the "fastest ship of her class in the world!" *Speed* appeals to the American mind. We are a very speedy people. But this quality is not the sole requisite in a fighting ship. It is important, very; but the ability to strike, and the strength to stand and take punishment are of more importance in battle. To run away at times may be to prevent defeat. To overtake an enemy may be gratifying. But the ship built to run away will be less feared, as a rule, for that reason; and the ship built to "overtake" will be whipped by the ship in which weight has been given to guns and armor.

The pneumatic gun should not be condemned because the fuses failed in the recent trials. This is a minor defect that can be easily remedied. The trials were in some cases very severe. The wonderful accuracy of a high-powered gun would not be fully demonstrated if the gun were mounted on board a ship moving sixteen knots and aimed at a target moving ten knots, the gun-captain being compelled to fire at the "word of command" and to estimate the range.

There are three important uses for the pneumatic gun: bombarding, countermining, and harbor defense.

The experiences at Alexandria and Sfax are sufficient to prove its usefulness in bombarding. One shell charged with 500 pounds of high explosive, landed inside a fort, would do more to demoralize a garrison and silence its fire than 50 projectiles from high-powered guns. Bombarding is one of the functions of a navy, and, in such an emergency, the weapon that can throw 500 pounds of gelatine 1500 yards would be invaluable. If this were the only possible use for the pneumatic gun, every navy should have a few such. The fact that high explosives have been, and may be very extensively, used in powder guns, does not affect the argument in the least. The bursting charges of such shells can never be very heavy, and the effect of the explosion will not compare with that of the immense charges fired from the pneumatic gun.

In countermining, and in destroying obstructions, booms, etc., the pneumatic gun would be invaluable. These are functions that a navy may have to perform in time of war. Shall no provision be made for such emergencies? To send boats to grapple for and cut the cables of a mine field or to blow up obstructions in a channel would be a forlorn hope. But the pneumatic gun can destroy a boom at the distance of a mile with a few

shots, and with the delayed-action fuse, shells planted at intervals along a ship-channel would serve to clear obstructions and possibly to destroy the electrical connections of a sub-marine defense.

In harbor and coast defense, the pneumatic gun is not restricted to the shore. Mounted on board a specially-designed ship, it could be placed at the outer entrance to a ship-channel to embarrass an attacking fleet. The ship for this work should be of light draught, so that she could manœuvre over the shoals where the enemy could not follow. She should have one gun in the stern in addition to those in the bow. She should be completely protected by a heavy steel turtle-back so that she could stand and take punishment. She need not be fast, and her coal endurance could be limited to two or three days, because she could run in for coal whenever necessary, and special facilities could be provided for coaling quickly. Thus the weight could be given to armor protection on a moderate displacement and light draught.

Such a ship could run from port to port along the coast to reach a threatened point. Against a squadron approaching in column to enter a ship-channel the chances of hitting would be greatly increased, since a shell passing over one ship might hit the next astern. A squadron manœuvring in regular formations, and within restricted limits off the coast between islands and shoals, would often present a large target for the pneumatic gun.

For bombarding and countermining the gun should be carried by a well protected cruiser of about 3000 tons displacement, with moderate speed, good coal endurance, and a battery of light rapid-firing guns—9-pounders, for instance. Such a ship would be available for general cruising purposes. She would not be a sacrifice to one idea. In time of war she would accompany an attacking fleet of armored ships, and taking cover behind the latter she would do her work in bombarding and countermining.

Two ships, one built to utilize the power of the pneumatic gun in coast defense, and the other to operate with a squadron on the offensive, would be nothing more than a proper recognition of the value of this weapon.

Lieut. RICHARD WAINWRIGHT, U. S. N.:—In the Prize Essay for 1893, Lieut.-Commander Schroeder has given us a careful estimation of the tactical value of the pneumatic gun for naval purposes. He has shown most carefully its limitations as a naval weapon; but at the same time he has thoroughly demonstrated that the tendency has been to place this limit too low and that the gun has a definite value as an auxiliary weapon.

Incidentally, and as a method of comparison, the prize essayist has indicated the value of the ram and the torpedo. Here are two auxiliary weapons, whose real value has been over-estimated to a harmful extent by their ardent admirers, that are now gradually assuming their natural level under the logical pressure of experience. The disaster that resulted in the loss of the Victoria was supposed to illustrate the immense value of

the ram; but it is known now, "that, had all the doors, hatchways, etc., been closed prior to the collision, the Victoria would have continued to retain ample buoyancy and stability, and would not have ceased to be under control." Each year's manœuvres tend to limit the use of the torpedo to its legitimate place in naval warfare. Even the Chinese are losing their faith in "moral effect," and are beginning to realize that guns in the hands of their braves are more dangerous to the enemy than dragon-flags. The guns of the main batteries of battleships will decide the issue of naval battles. Auxiliary weapons may serve to modify tactics, to modify the construction of vessels of war; but they cannot usurp the place of the gun.

The essay demonstrates that the pneumatic gun has a distinct value as an auxiliary weapon. It has the destructive effect of the torpedo, with far greater effective range. It requires considerable space, and the weights necessary to be carried are too great to allow it to be installed as an auxiliary to other arms on a war-vessel, as is done with the torpedo; but it must be carried on a vessel designed for or devoted to the purpose. Its high angle fire, limits of range and the general nature of its attack, prevent the pneumatic gun from taking the place of the modern high-powered gun; as its size, etc., prevent its taking the place of the rapid-fire gun. The size of the gun, the requirements as to knowledge of the distance of the target, prevent its use as a torpedo in dark or thick weather; but at the very time that a torpedo attack must fail, if attempted, is the time when the pneumatic gun would come into play. In daylight, when the distance can be determined by range-finders, the attack can be made by harbor-defense boats armed with the pneumatic gun. A blockading fleet can be forced further out, or a bombarding fleet disturbed in its attack upon fortifications. Its high angle of fire and great explosive effect will make it of great value in a bombardment, and it should prove of great assistance in clearing a channel through a mine-field.

While we have so few battleships, it would not be wise to divert much attention or a large proportion of an appropriation from our principal reliance in case of a naval war; but when we do commence to build fleets of torpedo-boats to assist in the protection of our coasts, we would be blind indeed to neglect the pneumatic gun.

There has been a strong prejudice against the pneumatic gun, it has had to struggle against the usual distrust of new inventions, and the absurd claims of some of those interested in its development. Besides this, the gun was brought before its critics in a most incomplete state, certainly as a naval weapon, while its projectors claimed that it was a perfected weapon. The essay shows in what an unfinished condition it was when first installed on the Vesuvius, and the Navy knows how much the present development of the gun is due to the skill and energy of the prize essayist. When first tried on the Vesuvius the gun was of no practical value; on the last trial it proved to be readily handled and accurate. The fuse

failed, but that was due to a slight mechanical defect that has been remedied by this time.

Quite lately we have had an object lesson that is peculiarly valuable for our country, which, at the present rate of increase of the Navy, must be unprepared for war for many years to come. In the rapid manner in which the merchant-steamer El Cid was converted into the war-vessel Nictheroy, we have a lesson that we cannot afford to ignore. For we know now that our merchant-steamers can be converted in a short time into vessels that will be powerful auxiliaries to our war fleet.

It cannot be claimed that a vessel carrying pneumatic guns would be fit to cope with one of the same or similar type armed with rapid-fire guns ; but it is claimed that they carry a weapon capable of destroying the heaviest armored battleship, and as it would be unadvisable, if not ridiculous, to pit costly battleships against unarmored steamers, the former must retire when attacked and the cruisers brought forward in the fight, and these again must keep beyond the range of the guns of the fortifications. So that, protected by the shore guns, the light vessels armed with pneumatic guns could make a formidable attack upon a fleet threatening our coast defenses. With Halifax and Bermuda in the possession of a possible enemy, we should cherish such an important auxiliary as the pneumatic gun would be to a fleet formed for the attack of a fortified town.

If the Prize Essay succeeds in drawing sufficient attention to the pneumatic gun and it is given a definite position in naval warfare, and its tactics are properly developed, the essayist will have well served his country.

Lieut.-Commander SEATON SCHROEDER, U. S. N. :—There does not seem to be much left to say on this subject. I think the position of the pneumatic gun, in the estimation of the Service, is rather higher now than it was a few years ago. Certainly, if everything had been committed to print that has been expressed to me in endorsement of the essay, several pages would be added to the discussion. What is of paramount importance, however, in the Institute, is the reasoning that leads to the formation of opinions.

I agree with Lieut. Ackerman that, as mounted in the Vesuvius, the pneumatic gun is not of as great general value as desired. And I follow him in some but not all of his arguments. First of all, I must emphatically disclaim any desire to compress the art of naval warfare into the narrow bounds of a single theory. And I must point out that he sanctions the use by a many-gunned battleship of yoked and other torpedoes in a duel with the Vesuvius. I think that is an admission that every known and practicable device will be used by battleships as by other vessels. A more crucial test of the pneumatic gun would perhaps be offered in a duel between two similar battleships, one of which had a pneumatic gun in addition to the

usual battery. In a fight between a battleship and a single torpedo-boat, the latter would have a still poorer show, having to come within a few hundred yards.

I also cannot agree that the possibility of the defense at Alexandria having a pneumatic gun constitutes an argument against the usefulness of one in the attacking fleet. The same argument would apply to any weapon. The statement that the battleship would certainly retire to a safe range under the circumstances is manifestly a concession to the value of that gun. Of course, all weapons are more efficient when installed on shore than when afloat, owing to the steady platform, and the facilities for range and position finding. All useful weapons, and plenty of them, is what a fleet needs. Among them should be automobile torpedoes; although, granting them a speed of thirty knots, the direction of the enemy 30 seconds afterwards must be known for a range of 500 yards.

All the various points raised by Lieut. Ackerman are, however, full of interest to me, and of importance in a professional discussion; as are also the more favorable criticisms by the other participants, with whom I agree.

I must not forget to mention that the general expectation has been realized—that the defects would be remedied in the mechanical details of the fuse that failed at Port Royal. It was a simple matter, and since the publication of the essay I have had the privilege of witnessing a successful test of the perfected design in some shell fired from a pneumatic gun at Sandy Hook. Some were charged with wet gun-cotton, and some with explosive gelatine. In every case the detonation was apparently complete and of the first order.

I am much obliged for the pleasant things said by various officers in the discussion, and am much pleased at the general attitude of endorsement.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE JOHNSON CAST STEEL ARMOR-PIERCING SHOT.

By Ensign R. D. Tisdale, U. S. N.

When men-of-war began to use iron armor, there was required a projectile that could penetrate it. The old spherical, solid shot were very good when used against wooden ships or those carrying the primitive armor; but it was soon found that wrought iron armor was more than a match for them, and the elongated pro-projectile with solid point became a necessity. In 1876, chilled cast iron projectiles were considered all that could be desired for work against wrought iron armor. A little later, by an exhaustive series of experiments in England, it was proved that against steel armor, steel projectiles must be used. Thus came the struggle between the gun (hence projectile) and armor. Compound armor followed wrought iron, then steel armor, until to-day we have those excellent American nickel steel plates, and, better still, those plates with Harveyized surfaces. To compete with these, we have the forged steel A. P. projectile of to-day, in its infancy as late as 1886, but now capable of piercing, without any serious injury to itself, any non-Harveyized nickel steel plate of a thickness equal to 1¼ times its own caliber, at a fighting range of 1500 yards, using standard full charges.

In the development of forged steel A. P. projectiles, nearly all idea of making a cast steel projectile do the same work seems to have been lost sight of. The large cost of a treated forged steel A. P. projectile may be the only inducement without experiment in looking for a cheaper projectile.

The Messrs. Isaac G. Johnson & Co., of Spuyten Duyvil, N. Y., have been experimenting with cast steel for A. P. projectiles, and to trace the results is the purpose of this article. As the armor plate is closely allied with the projectile in any such experiment, a description of the work done on the plate becomes a necessity.

Each shot presented for test has represented some special treatment, both as regards the quality of material and method of manufacture. These shot are still in the experimental stage, no lot being offered, and none accepted. The desideratum seems to be to penetrate a steel plate of the shot's caliber in thickness, without injury to the shot; although the Messrs. Johnson propose to use successfully their shot against Harvey plates, and meet all requirements for forged steel A. P. projectiles.

On Aug. 11, 1892, a 10″ and a 12″ Johnson cast steel shot were tested against the Monterey's 13″nickel steel ballistic plate, furnished by Carnegie, Phipps & Co. The weight of the plate was about 10.7 tons, mounted securely on 36″ of oak backing on a target structure. The 10″ Johnson shot, oil tempered, with a striking velocity of 1700 f. s., and striking energy of 10,030 ft. tons, struck the above plate 28″ from the left edge, and 26″ from the bottom, point penetrating about 7″. The shot broke up into four principal pieces—the ogive in one, swelled in diameter at the bourrelet to 12½″, preserved its shape and point quite well; the remaining pieces formed the body of the shot. The fractures in the shot showed a fine grain approaching that of tool steel. The plate was split with three wide through cracks, thus showing the value of the oil tempering in making an armor-breaking projectile.

The 12″ shot, untreated, was fired with a striking velocity of 1575 f. s., striking energy 14,633 ft. tons, striking plate 30″ from right edge, and 32″ from top. This shot broke up badly, the head mushrooming on plate, to a diameter of 18″. A dish-shaped hole, about 4″ deep and 18″ in diameter, was made at the impact, but the plate remained uncracked there.

Illustration No. 1 shows the effect on the plate, as well as the fragments of the shot, which are placed under their impacts. These shot behaved very similarly to cast shot tried years before, on much inferior armor; but the test shows the value of oil tempering, and the valueless character of untempered projectiles.

On March 18, 1893, the Messrs. Johnson submitted two 10″ cast steel shot, which were tried against the New York's 10½″ nickel steel ballistic plate weighing about 11½ tons. This plate was firmly secured to the usual oak backing. It had already been attacked in its ballistic test by three 8″ forged steel A. P. projectiles. A fine through crack extended from the upper right hand

ILLUSTRATION NO. 1.—Test of Johnson Cast Steel Shot against Monterey's 13-in. nickel steel plate, Aug. 11, 1892.
Left Impact: 10-in. shot, striking velocity 1700 f. s.; fragments shown beneath.
Right Impact: 12-in. shot, striking velocity 1575 f. s.; fragments shown beneath.

ILLUSTRATION NO. 2.—Test of Johnson 10-in. Cast Steel Shot against New York's 10½-in. nickel steel plate, March 18, 1893, showing the two shot after recovery. Left shot No. 10-3, striking velocity 1300 f. s.; right shot No. 10-1, striking velocity 1500 f. s.

shot hole to the right edge of the plate, but the entire condition was very good. The first Johnson shot, No. 10-1, was fired with a striking velocity of 1500 f. s., striking energy 7808 ft. tons. The impact was 28″ from the left edge, and 34″ from the top of the plate. The shot penetrated entirely the plate and backing, but broke into two principal pieces. The ogive with part of the bourrelet, weighing 213 lbs. was recovered 3 feet in the ground about 500 yards distant; and the base, about 9″ long, weighing 185 lbs., after striking the hill opposite the target, was stopped by a tree 200 yards distant. The fractures of both fragments were transverse and clean, being in planes at right angles to the axis. The point of the ogive remained fairly sharp; and the only change observed in dimensions was an increase of 0.04″ at the bourrelet. The normal fringe and bulge were raised on the plate. Radiating from the impact were a fine through crack to the left edge, and another to the top of plate. The old crack in the plate was further developed.

In the second round, shot No. 10-3, with a striking velocity of 1300 f. s., and striking energy of 5865 ft. tons, struck the plate 44″ from the left edge, and 24″ from the bottom; penetrated about 6″; rebounded a little to the front and fell on the ground, having been broken into two pieces. The point, weighing 33 lbs., was very much upset, and had lost its sharpness. The remainder of the shot was considerably distorted and upset; the remaining portion of the ogive and bourrelet, mushrooming, cracked into a rather regular series of longitudinals, from 3″ to 6″ long, 2.5″ deep, and from a thousandth to 0.25″ wide, resembling very much those that might be formed by heavily upsetting any ordinary cast iron or cast steel rod. The maximum diameter of the shell was 12″, and the estimated shortening about 6.2″. The plate was further cracked, and the old cracks developed.

Illustration No. 2 shows the two shot after recovery.

The manner in which these two shot broke up shows very clearly in which direction the weakness lay. The material seemed to be very good, from the fractures.

The first shot had a velocity that would carry a good forged steel A. P. projectile through. The result—penetration and cracking of the plate—was all that could be expected; and whether the value of the shot after breaking into two parts was lessened would depend upon the actual character of the target behind.

The second shot as an A. P. projectile was not a failure, as the striking energy was too low to admit of complete penetration, although this lower velocity brought out the inherent weakness of the projectile.

On Sept. 5, 1893, the Messrs. Johnson submitted to test three more cast steel shot. Two were solid, numbered $\frac{\text{P-12}}{1}$ and $\frac{\text{P-12}}{3}$, and about the same as Nos. 10-1 and 10-2 of the previous test. The third, $\frac{\text{P-12}}{2}$ (fired in the last round) was not solid, but had a cavity 1.3″ diameter and 22.5″ long, thus giving a solid head of about 7½″. This cavity was in the line of an experiment regarding the tempering of the shot. The target used was the Indiana's 17″ curved, nickel steel ballistic plate, secured to a 36″ oak backing on a very solid structure. This plate had been previously attacked by four 12″ Carpenter forged steel A. P. shell, but was entire and but slightly cracked, and in good condition.

Round 1.—Shot No. $\frac{\text{P-12}}{1}$, with a striking velocity of 1400 f. s., and striking energy of 6850 ft. tons, line of fire inclined about 5° with the normal at impact, struck the plate 32″ from top and 72″ from right edge, near center line, and not less than 2½ calibers from the nearest shot hole; it penetrated 13.5″, breaking up at the bourrelet. The ogive, weighing 57 lbs., remained whole, uncracked, but increased in diameter at the bourrelet 0.09″ and rebounded 50 ft. to front of target. The remainder of the shot was delivered in fragments weighing from 1 to 100 lbs. to a distance of 250 ft. in front of target. In penetrating, the point turned to the right and upwards, so that the line of penetration was about 10° with the normal. A regular fringe and bulge formed around the shot hole. A fine crack was opened to impact No. 2, another to top of plate, and an old temper crack from impact No. 2 to bottom of plate—plate dished about ½″. This shot appeared to have a hard point about 2″ long, soft ogive to bourrelet, and hard from bourrelet to within 4″ of the base. The point had remained in excellent condition, and the junction between the hard point and soft ogive was quite marked to the touch.

Round 2.—Shot $\frac{\text{P-12}}{3}$ struck the plate 50″ from the right edge, 40″ from the bottom, and 20″ from the nearest 12″ impact; line

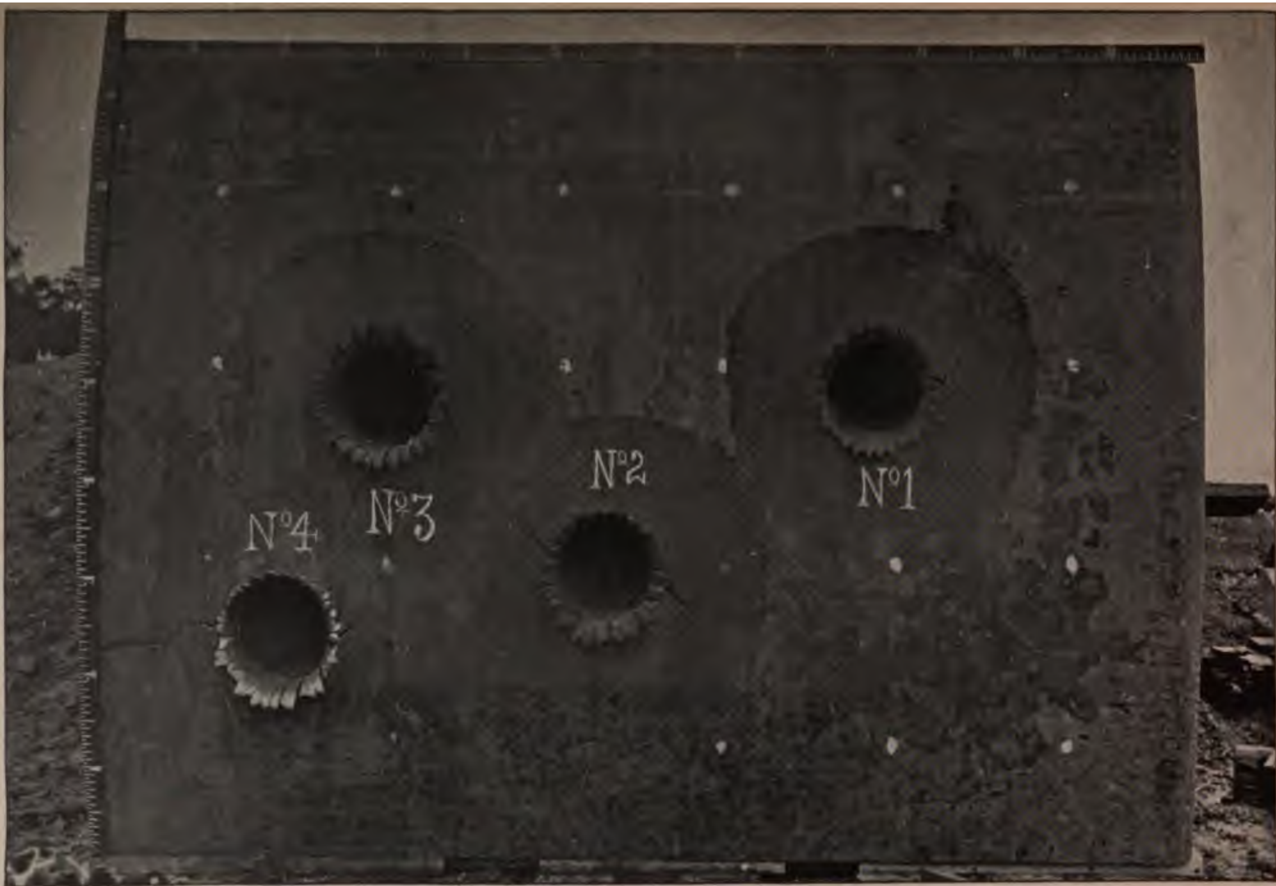

ILLUSTRATION NO. 3.—Test of three Johnson 10-in. Cast Steel Shot against Indiana's 17-in. nickel steel plate, made September 5, 1893, showing the condition of the plate before firing.

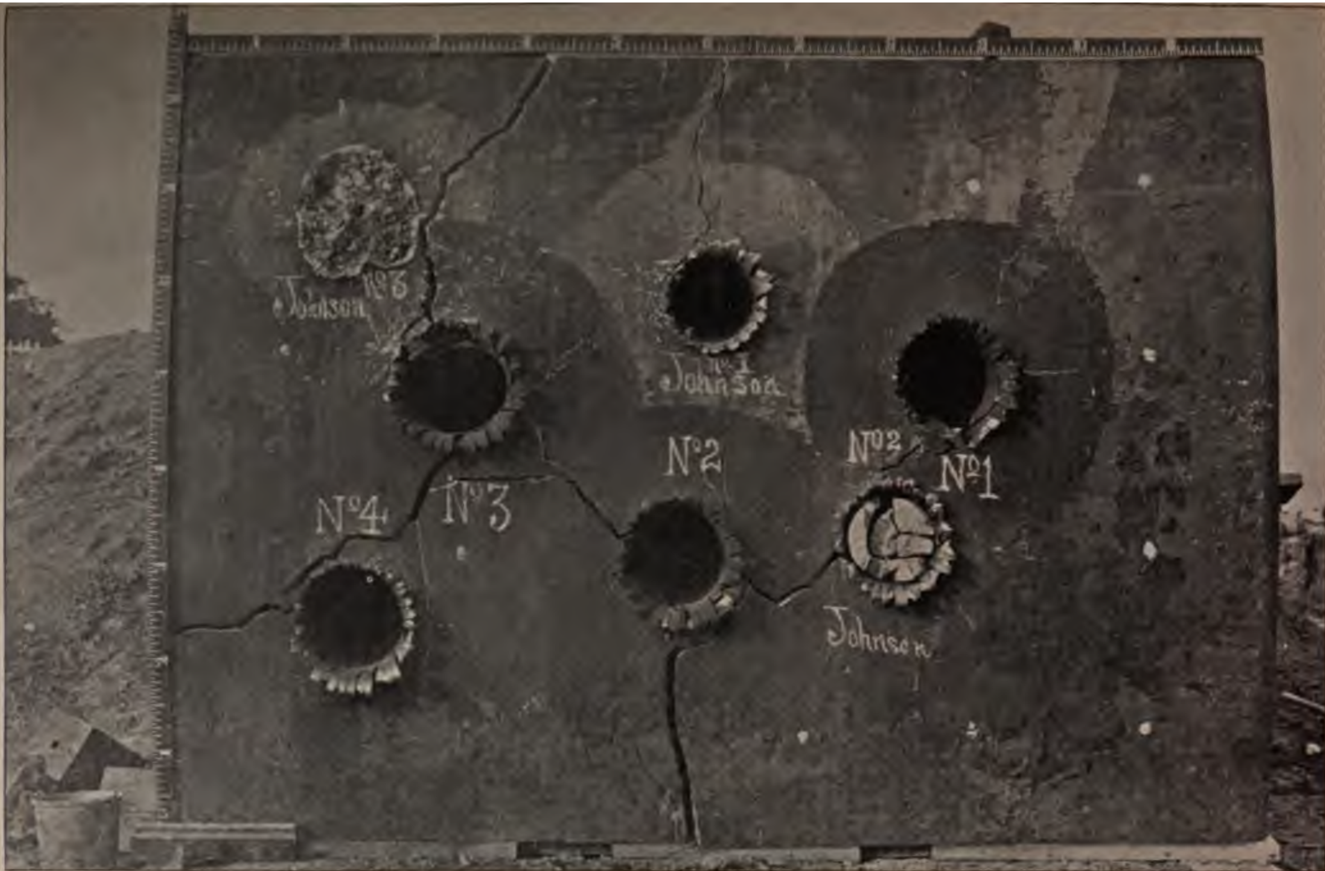

ILLUSTRATION NO. 4.—Test of three Johnson Cast Steel Shot against Indiana's 17-in. nickel steel plate, made Sept. 5, 1893, showing the condition of the plate after firing.

Johnson Impact No. 1, striking velocity 1400 f. s.; No. 2, striking velocity 1890 f. s.; No. 3, striking velocity 1400 f. s.

ILLUSTRATION NO. 5.—Test of Johnson 10-in. Cast Steel Shot No. $P\frac{12}{1}$ against Indiana's 17-in. nickel steel plate, made Sept. 5, 1893. Striking velocity 1400 f. s., showing the fragments of the shot after recovery.

of fire inclined 5° with normal, striking velocity 1890 f. s., and striking energy 12,495 ft. tons. The projectile after penetrating 19", cracking through the back bulge, broke off flush with the face of the plate; the ogive and upper body, much shattered, stuck in the shot hole, the remainder being delivered in all directions in front of the target for a distance of 100 yards. Through cracks in the plate were developed between this impact and 12" impacts 1 and 2, and around the latter.

Round 3.—Cast steel shell $\frac{\text{P-12}}{2}$ with a striking velocity of 1400 f. s., striking energy 6850 ft. tons, struck the plate in upper left hand corner, 22" from top and 26" from left edge, line of fire 7° with the normal. This projectile smashed on the plate; the point, penetrating about 8", remained welded into the plate, while the remainder, in many fragments, was delivered over the face of the plate, cutting off the fringe, and in all directions for 200 yards. The splash of the shot was about 17" in diameter. By this impact the plate was practically divided into four parts, but all remained on the backing.

To sum up the results of the above: In the first round, a penetration about equal to that of a 10" armor-piercing projectile having the same striking energy, was obtained; and as it would have rebounded, the breaking of the cast steel shot did not detract from its value. In the second round, a striking energy was given sufficient to carry a 10" A. P. projectile through the plate, and the shot, although the penetration was quite remarkable for cast steel, fell a little below an A. P. in its value as to penetration, but not as to cracking the plate.

The third cast steel shot, or rather shell, seemed to be laboring under both external and internal strains, as shown by the manner in which it broke up. The mining effect however was all that could be desired—the plate was demoralized. The material of all seemed to be good. The superiority of this lot over the previous two tested is sufficiently marked to show that some advancement had been made in the manufacture.

Illustrations Nos. 3 and 4, showing the plate before and after firing the Johnson shot, and No. 5 showing one shot recovered, clearly indicate the real work done.

On January 9 and 10, 1894, four more Johnson shot were tried.

The Maine's 10″ nickel steel ballistic plate was used, having been attacked in its test by three 8″ A. P. shell. It was apparently in excellent condition, entire with no visible cracks; weight about 15.5 tons, securely mounted on 36″ of oak backing.

Round 1.—Shot No. B-1, with a striking velocity of 1570 f. s., and a striking energy of 8629 ft. tons, struck the plate 23″ from the top, and 29″ from the left edge, line of fire normal at impact. It penetrated the plate and backing, 10 ft. of earth, and fell on the river bank 200 yards distant, entire, uncracked, and unchanged in dimensions. The only change in the shot was the beveling off of the edge of the base below the band score, caused by the gripping of the plate. It could have been reloaded in the gun. A through crack ran from impact to top of plate, and a fine one to nearest 8″ shot hole. The backing was considerably crushed in the upper left hand corner.

Round 2.—Shot No. B-2, was fired with a striking velocity of 1490 f. s., striking energy 7772 ft. tons; it struck the plate normally 22″ from left edge, and 30″ from bottom, penetrated plate, and lodged in back bulge of plate and backing, the base being 6½″ from face of plate. When gotten out, the shot was entire, considerably upset in the ogive and upper body, being shortened 1.58″, bourrelet increased in diameter 0.36″. The point was distorted 0.3″ from the original axis, but remained fairly sharp. A fine crack of unknown depth extended from lower edge of bourrelet to within 2″ of point, parallel to axis of shot; the remainder of the shot was in excellent condition. The upper left hand corner of the plate was split out from the rest of the plate, and hung by one armor bolt. A crack was opened out from this impact to the nearest 8″ shot hole, and several fine cracks in the 8″ bulges.

Round 3.—Shot No. 4, with a striking velocity of 1520 f. s., and striking energy of 8056 ft. tons, struck normally the center of an apparently uncracked portion, 3 ft. x 4 ft., not separated from the remainder of the plate, impact being about 48″ from bottom, 48″ from left edge; it penetrated plate and backing, and an 18″ oak upright, and was deflected into the river by an iron angle plate. This impact wrecked the left half of plate and backing, throwing a fragment weighing ½ ton 100 yards to the left up the hill, and many other fragments to points within a radius of 300 yards. All the armor bolts except four were broken and driven to the rear.

Illustration No. 6.—Test of four Johnson 10-in. Cast Steel Shot against Maine's 10-in. nickel steel plate, made January 9 and 10, 1894, showing the condition of the plate after the fourth round, and shot No. 5 stuck in an oak upright.

ILLUSTRATION NO. 7.—Test of four Johnson 10-in. Cast Steel Shot against Maine's 10-in. nickel steel plate, made January 9 and 10, 1894, showing the three shot recovered:

No. B-1, striking velocity 1570 f. s., 1st round. No. B-2, striking velocity 1490 f. s., 2d round.

No. 5, striking velocity 1400 f. s., 4th round.

Round 4.—Shot No. 5 struck the center of the lower right hand corner of the plate, a piece about 3½ ft. square, at an angle of about 3°, with a striking velocity of 1400 f. s., and a striking energy of 6848 ft. tons. The shot penetrated the fragment and backing, sticking in an 18″ oak upright. On being cut out, it was found to be entire, uncracked and symmetrical, bourrelet increased in diameter .06″, shortened 0.34″, but the shot could not be reloaded in the gun. The point, though blunted slightly, was in excellent condition.

With the exception of the shot of the second round, all of these shot show a performance equal to that of good forged steel A. P. projectiles. All should have perforated the target with the velocities given in each case.

Illustration No. 6 shows the effect on the target, and No. 7 the three shot recovered.

The uniformity of results in the above four rounds shows an improvement. None of these shot were hard, the file showing alternate harder and softer zones on the exterior. The metal of each, from the results, seemed to be tough. Each shot represented something different to the manufacturers.

All the above tests were against nickel steel armor, but the next one, taking place on March 10, 1894, was against an experimental 10½″ Harveyized nickel steel plate, furnished by the Carnegie Steel Company. Two 8″ armor-piercing projectiles, with striking velocities of 1840 f. s. and 2000 f. s. respectively, had comprised part of the experimental test of this plate before the Johnson shot was fired, which completed it. About two-thirds of the plate, originally weighing 9½ tons, remained for the Johnson impact.

Shot No. B-7, striking velocity 1500 f. s., striking energy 7808 ft. tons, struck the plate about 32″ from top and 37″ from left edge, and about midway of the 8″ splashes on plate. The point and ogive welded into the plate; estimated penetration 6″ to 7″, shown by a back bulge of 2″ and the amount of shot welded in. The remainder of the shot broke up into numerous fragments, the heaviest weighing 29 lbs. This impact wrecked the plate and backing, throwing the piece in which the shot was welded, weighing about 1½ tons, over the top, and 20 feet to the rear of the target. Four other heavy pieces of the plate were thrown to the sides and rear of the target as far as 100 feet.

The action of this shot was similar to that of a regular forged steel projectile. It did not have sufficient energy to penetrate the plate entirely, though enough if it had not been Harveyized. As an armor-breaker it acted quite well.

Illustrations Nos. 8 and 9, showing the plate before and after firing, and No. 10, showing the fragment in which the ogive was welded, illustrate the performance of the shot.

On March 21, 1894, Johnson 10" shot No. B-4 was tested against a 12" Harveyized nickel steel plate, weighing about 10¾ tons, furnished by the Carnegie Steel Company. This shot was of normal weight and dimensions, and soft to the file all over the surface. With a striking velocity of 1600 f. s., and a striking energy of 8884 ft. tons, this shot struck the above plate 26" from left edge, and 19" from top. It smashed on the plate, the point and ogive penetrated to a distance of 6.5", and welded into the plate, while the remainder of the shot was delivered in small fragments within a radius of 150 yards in front of the target. The splash was about 15" in diameter, and the plate was scaled off around it. A fine through crack to the left edge, and another to the top of the plate were developed. The whole target structure was set back about 2" at top.

Immediately after this round, a forged steel A. P. projectile was fired against the same plate in the lower right hand corner, having the same striking velocity and striking energy. This shell smashed on the face of the plate, ogive welding itself into plate, and penetrating about the same distance as the Johnson shot. The impact of the latter shook out the welded ogive of the Johnson shot, thus enabling the penetration to be measured. To all intents and purposes, judging from the second round, the Johnson cast steel shot did as much work on the plate as the forged steel projectile did. Illustrations Nos. 11 and 12 show the splash of the above Johnson shot on the plate, and the impact of the Carpenter A. P. shell.

On March 23, 1894, three 10-in. shot of the same lot as those tested on March 10 and 21, but each no doubt representing something different to the manufacturers, were tested. Each shot was soft enough to take a file all over the surface.

Shot B-6 was fired against the Monadnock's 11½" curved nickel steel plate, weighing about 11 tons, which had already been attacked by one 8-in. forged steel A. P. projectile in its ballistic

ILLUSTRATION NO. 8.—Test of Johnson 10-in. Cast Steel Shot B-7 against a 10½ experimental Harveyized nickel steel plate, showing the condition of the plate before firing.

ILLUSTRATION NO. 9.—Test of one Johnson 10-in. Cast Steel Shot No. B-7 against a 10½-in. experimental Harveyized nickel steel plate, made March 10, 1894, showing condition of the target after firing the shot with a striking velocity of 1500 f. s. (3d round on plate.)

ILLUSTRATION NO. 10.—Test of one Johnson 10-in. Cast Steel Shot No. B-7 against a 10½-in. experimental Harveyized nickel steel plate, made March 10, 1894, showing a fragment of the above plate containing the welded ogive of the shot.

ILLUSTRATION NO. 11.—Test of Johnson 10-in. Cast Steel Shot against a 12-in. Harveyized nickel steel plate, showing the splash of shot on the plate.
Johnson Shot No. B-4, striking velocity 1600 f. s.

ILLUSTRATION NO. 12.—Impact No. 1, that of Johnson 10-in. Cast Steel Shot B-4. Impact No. 2, that of a Carpenter forged steel A. P. shell. Striking velocities 1600 f. s. Plate, 12-in. Harveyized nickel steel.

ILLUSTRATION NO. 13.—Test of Johnson 10-in. Cast Steel Shot B-6 against Monadnock's 11½-in. curved nickel steel plate. Striking velocity 1500 f. s. Showing the *shot after passing* through the target.

ILLUSTRATION 14.—Test of Johnson 10-in. Cast Steel Shot B-5 against a 12-in. Harveyized nickel steel plate, showing the

test; it was, however, sound and uncracked. This shot, with a striking velocity of 1500 f. s., striking energy of 7808 ft. tons, struck the plate normally, 24″ from the top, and 40½″ from the right edge; it penetrated the plate, 36″ of oak backing, a 12″ oak strut, about 10 ft of earth, and landed 200 feet to rear of target. It was found to be entire, uncracked and symmetrical, shortened 0.6″, bourrelet increased in diameter .06″, and it lacked 0.01″ of the possibility of being reloaded in the gun. By this impact the plate was cracked through (from 2″ to 7″) from top to bottom, exposing the backing, was much broken around the shot hole, the back bulge broken off to a depth of 4″ and 30″ in diameter, while the lower part of the front bulge stood out in a large scale 2½″ thick. The shot hole and fragment of plate were very hot. Illustration No. 13 shows the shot after recovery. In this instance, the shot did all the work that could have been expected of a forged steel projectile.

Two shot were then tried against the 12-in. experimental Harvey nickel steel plate used in the test of March 21. Illustration No. 12 shows its condition.

Round 1.—Shot No. B-5, with a striking velocity of 1600 f. s., striking energy 8884 ft. tons, struck the plate normally, 30″ from the bottom and 24″ from the left edge, and broke up into a large number of pieces, the heaviest recovered weighing 19½ lbs. The point welded into the plate, having penetrated 4½″ (estimated). The impact was more or less cone-shaped. All old cracks in the plate were developed, some exposing the backing, and a new one was formed, running from the left edge to this impact, thence to an old one to bottom of plate. The backing and structure were considerably injured and displaced. Illustration No. 14 shows the condition of the target after this round.

Round 2.—The target having been resecured as rigidly as possible, shot No. B-3 was fired against it. This shot had a soft steel cap, cylindrical in shape, 5″ in diameter, and 3½″ long, accurately fitted over the point of the ogive, and secured by three short screws placed 120° apart, fitting into shallow pockets in the surface of the ogival, about 3″ from the point. The total length of the shot was increased about ½″ thereby, and total weight to 510 lbs. Illustration No. 15 shows the shot with the cap secured to it.

This shot, with a striking velocity of 1600 f. s., striking energy of about 9100 ft. tons (including extra weight of cap) struck the

plate 30″ from right edge, and 10″ to the left of the soft (not Harveyized) strip in plate (showing white in illustration) and 22″ below the Carpenter 10-in. impact (No. 2). By this impact the target was completely wrecked, the plate being divided into eight principal pieces. The shot penetrated to within 3″ of the back of the plate, punching off the back bulge, and then broke up into many fragments. It would seem that, in penetrating the hard surface, the shot remained whole. The point was recovered undeformed but deeply scored, having been broken off in a plane through the screw pockets. The pieces of ogive preserved their form very well. The plate and its fragments around the shot hole were very hot, but no piece of the shot was too hot to pick up with the naked hand. Illustration No. 16 shows the fragment of plate containing the shot hole.

This round shows the value of the soft steel cap. It supported the point of ogive in passing through the hard surface of the plate, so that on reaching the softer metal, the penetration resembled that in an ordinary plate. The action of the cap resembles very much that of a soft plate placed in front of and close to the *hardened* surface of an armor plate. Some successful experiments of the latter character have been made abroad recently.

The screw pockets in the ogive of shot B-3 evidently weakened the point, as shown by the manner in which it broke off.

The fragments of both Nos. B-5 and B-3 showed a fine grain, approaching, in some parts, that of tool steel.

The above results cannot be considered otherwise than excellent for *cast* steel shot. In the last three instances these shot have showed themselves equal to many forged steel projectiles. It is to be hoped that the Messrs. Johnson will continue to be as successful when they manufacture lots for sale to the Government.

ILLUSTRATION No. 15.—Showing Johnson 10-in. Cast Steel Shot B-3 with the soft steel cap on.

ILLUSTRATION No. 16.—Test of Johnson 10-in. Cast Steel Shot B-3 (with soft steel cap) against a 12-in. Harveyized nickel steel plate; striking velocity 1600 f. s., showing the fragment of the plate containing the shot hole (4th round).

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE BATTLE OF LA PLACILLA.

By Captain W. S. Muse, U. S. M. C.

A description of the Battle of La Placilla, prepared by Lieutenant J. H. Sears and Ensign B. W. Wells, U. S. N., is given in War Series No. IV., issued by the Office of Naval Intelligence. It is, however, unaccompanied by a good map of the battlefield. The battle map accompanying the present remarks is copied from one prepared by two officers of the Constitutional Army, and countersigned by Colonel Emilio Körner, Chief of Staff of that Army. Colonel Körner had been in the German Army during the last Franco-German War, and, coming to Chile, had of late years been instructor in the military school. He seems to have been in the war, in addition to Chief of Staff, a sort of Chilean Stonewall Jackson. It may be added that the account here given is gathered largely from Chilean officers present in the battle, from an inspection of the field a few days after it, and a second inspection a few months later.

The lesson of La Placilla is of course one principally of sea-power. It is true that it is also a lesson in the use of cavalry against magazine small-arms and the most modern type of artillery in excessive proportion, and in commanding positions. But, primarily, the battle of La Placilla would have been impossible had not the Chilean Navy been on the side of the Constitutionalists. Through loss of sea-power, Balmaceda had lost the power of the initiative. The Constitutionalists, or Opositores, constituting an army of about ten thousand men, well armed and equipped, were able to concentrate in their stronghold of Iquique, making such feints at Coquimbo as to succeed in drawing an army of about eight thousand Gobernistas to that point. Likewise, similar Government armies were stationed

at Talcahuano, Valparaiso and Santiago. Quick concentration could not be effected on or from Coquimbo, as there was no railroad to it and communications by sea would be cut off. The army placed there was, accordingly, the flower of Balmaceda's forces, as he could not spare Coquimbo to the Opositores. The railroad maintained, fairly quick concentration could be effected between Santiago and Valparaiso, or from Talcahuano through Santiago to Valparaiso. Balmaceda knew that the blow was about to fall, but where? The Esmeralda patrolled along outside the harbor of Valparaiso, stopping all egress and ingress, and before the Gobernistas knew it the Constitutionalists were in the immediate vicinity of Valparaiso.

The Constitutionalists, or Opositores, quietly disembarked unopposed, on Aug. 20, from the Chilean fleet of transports at Quinterors, about 18 miles to the northward of Valparaiso, and tried to advance on Valparaiso from that direction. They found their way blocked at length by the Gobernistas, or supporters of President Balmaceda, at the Concon river, near its mouth. A battle ensued, in which the Gobernistas were driven back from their position and, according to report, away from the coast, so that, unknown to the Opositores, the way was wide open to Valparaiso from the northward. For some reason, probably that the Constitutional Army was not so sure of its strength as it might be, the victory gained at Concon was not immediately followed up. When attempt was made to follow it up by the Constitutionalists, they found the army they had first met reinforced by another of Balmaceda's (which had come by rail from Santiago) in an unassailable position on heights across an open plain at Vina del Mar, with the only opening into the city of Valparaiso a narrow defile, on one side of which was the sea and on the other Balmaceda's host. And finally, the defile was well guarded by one of the forts defending the harbor, namely Fort Callao, which, with the aid of two 11-inch Krupp guns, had, up to this time, managed so well to keep the fleet at a distance. An artillery fight followed, unsupported by any infantry or cavalry movements and, as might have been expected, no results ensued. The Opositores withdrew at night, leaving their camp-fires burning to deceive the Gobernistas, and for a few days were lost completely to the Balmaceda forces, whose cavalry seems to have done little in the way of scouting. This was due possibly to the superiority of the cavalry of the Constitutionalists, or probably to the fear of

treason from detached Government forces. In any event, the Constitutional cavalry must have held the command of the outlying country. The touch of the Constitutionalists was felt when the telegraph line between Santiago and Valparaiso was cut, but the point of cutting was unknown with certainty. A range of hills rises from Valparaiso, separating it from the interior country by a barrier impassable to a large force, composed in part of artillery and cavalry and hauling the munitions of war, except by one of two routes, viz.: by or through the pass to the northward, already spoken of, or by a road over the hills immediately to the south-east of Valparaiso and north-east of the little settlement of La Placilla. This latter road is the old road to Santiago (whereas the railroad passes through the northern defile). On reaching the level, fertile plain at La Placilla, after zigzagging down the steep side of a table land, the old road sends a branch northward. Ascending from La Placilla going to Valparaiso, just beyond the highest point indicated by the name Alto del Puerto, the road branches, the branches all going by an easy descent to Valparaiso distant six miles. A fair private road, however, goes off to the northward from the main road on the line marked Deslinde de Las Cenizas. This road is nearly level for the extent of the battlefield, its lowest point on the field being in the neighborhood of the left centre battery of the left wing of the Gobernistas, as shown on the map. At this point, the ridge over which the private road passes is scarcely more than fifty yards in width, and the gulleys on each side are practically impassable under fire, the sides being a severe climb at any time, unencumbered. In fact, it would appear that one might as well try to cross a bridge in the face of gun-fire as this ridge properly commanded. It may well then be said that the left flank might have been made impregnable by 100 yards of intrenchments. The centre of the position represented by the large turn in the road was likewise impregnable, a fact attested by the heavy slaughter in front of and near it, and the fact that, in spite of the heavy assaults, it was firm to the last. The right flank of the position was, unfortunately, weak, in spite of the fact that it was on a hill much higher and steeper than Cemetery Hill at Gettysburg, but still not too steep for cavalry to climb; for cavalry carried this position. Its weakness must be accounted for partly by the fact that tufts of high cane grow on the slopes and that these obscured the view of what was

going on in the gulley, a thing which does not obtain in the centre or in the steep, impracticable gulleys before the left flank. These tufts of cane, ten feet high or more, are sufficiently apart not to impede the free movements of a horse, while they would obscure him and rider till immediately below the crest of the hill. Good cavalrymen, such as the Chileans make, being wonderful horsemen, would find no real difficulty in the climb, and when sent to reinforce the left wing of the Constitutional Army they really did get around the flank and in the rear of the Gobernistas at a dash. The right wing driven in, the turning of the left, and gaining of the Santiago road from the direction of Deslinde de Las Cenizas, meant rout, and this seems to have happened. The natural line of retreat would have been along the table land to the Alto del Puerto, and then down hill all the way to Valparaiso. The Granados Carabiniers in the rear made a firm stand, as shown by the wreck, and saved a remnant of the disorganized army.

The artillery on the edge of the plateau above La Placilla was of the very latest pattern, complete in every particular, and the number of pieces was very large. The sound of the battle could be heard from the U. S. cruisers San Francisco and Baltimore in the harbor of Valparaiso, and was followed at no great interval by the sight in the distance, outlined against the sky, of numbers of fleeing men on the hills to the eastward and southward. At first uncertainty reigned, and then the real news came. The municipal authorities of Valparaiso fled. The foreign naval commanders took charge at the Intendencia and kept the mob out till the Opositores occupied it, when the town was turned over to them. The strongest adherents of President Balmaceda sought refuge on the foreign warships in the harbor. The victorious troops entered the city about 1 P. M. The first to arrive at the plaza was a bugler on a donkey. Behind him on the donkey was one of the citizens of the town, who had jumped there to show his appreciation of the event. This was followed by a few scattered men in advance of the main body. All the foreign ships of war had troops ashore for the protection of property belonging to their citizens, the forces having landed on the receipt of the news. Those from the San Francisco consisted of 120 sailors and 50 marines, under Lieut.-Commander Tilley.

It must not be imagined that the battle of La Placilla was a

scrimmage, or on the other hand, a walk over for one side. It was a hard-fought battle and lasted only about an hour because of the rapid-fire magazine arms used on both sides; the Constitutionalists had small-calibre arms and carried therefore the greatest number of rounds of ammunition. It is said that the small-calibre arms had a very demoralizing effect on the Government troops. One of the points brought most forcibly to the front, however, was the use of the cavalry charge at the opportune time. With no infantry reserves to call upon, General Körner having called upon the last reserves in a herculean effort against the left of the Government troops, General Canto, who, besides being Commander-in-Chief, was in immediate command of the left wing, resolved to sacrifice his cavalry if necessary against the right of the Government troops, and, in spite of the steep ascent, they managed to get round the right and come up in rear of the Government artillery. The following is a description of the position and battle in more detail, dealing more particularly with what took place on the left flank of the Government troops.

On the discovery of the Constitutionalist troops to the eastward of Valparaiso, August 25, the Government troops dropped their position at Vina del Mar and made all haste by night and day marches on the inside route to get to the position at La Placilla, as its value could be seen at once by any military man and was well known to the Chilean leaders. It is, in fact, the eastern key to Valparaiso. Early on the morning of the 27th of August, 1892, General Barbosa, commanding the Army of Chile defending Valparaiso, occupied the hills overlooking La Placilla, as before indicated. He deployed his forces along the crest of the hill. The artillery was placed in the centre on the right and left of the road over the hill. The road was lined with sharpshooters. Being well sunken, the bank towards the enemy formed natural rifle pits topped with stone. The artillery was high enough above this road to fire over the heads of their sharpshooters. The extent of Barbosa's front was about a mile and a half, the flanks resting on deep gulches; reserves in rear of the right, with cavalry in their rear. The whole force amounted to about 9000 men. The position was excellent. The little cane which grew in tufts in front of the right wing could easily have been cut by a few men with knives or machetas, giving a clear field of fire. One hundred yards of earth-

works across the left flank would have secured that, but, strange to say, they rested here twenty-four hours before the battle began and neither cut down a bush nor threw up a spade full of earth to strengthen their position. Naturally strong, with a little work it could have been made almost impregnable. General Canto, in command of the Opposition Army, reached Las Cadenas with his forces about 10 A. M. on the 27th and with them took position behind a range of hills, which hid them from the Government troops. It is distant about three miles from La Placilla. Here Canto halted to gather in his stragglers, rest his men, who had marched nearly all night, and form his plans for attack. He could easily reconnoitre the enemy's position from the hills in his front. The morning of the 28th opened foggy. At about 7 A. M., Major Huse, an ex-U. S. Cavalry officer serving on General Alcerreca's staff, noticed what he supposed were troops moving towards their left flank and he called the General's attention to it. After watching them for some time through his glasses, the General however decided that they were only cattle. About this time, an advance on the centre was discovered, and it was opened upon by the artillery. This was replied to by the enemy's artillery and skirmishers, and no further attention was paid to what General Alcerreca had pronounced to be cattle.

General Canto had divided his army of about 12,000 men into three parts, and what Major Huse had seen was the right with which Colonel Körner was feeling for the Gobernistas' left flank; they worked their way around this left and turned it. The 2d Regiment of the Line, Government troops, was sent to reinforce the left flank when it began to fall back, but this regiment went bodily over to the Opositores. Some cavalry worked their way up the gulch, in rear of the left flank and surprised and captured General Barbosa; after he had surrendered to an officer, he was shot and killed by a cavalryman. Later, as the right was driven in, General Alcerreca, commanding it, was wounded; and while being carried to the rear in an ambulance was captured and murdered. Before 10 A. M., the battle was over; many Gobernistas went over to the enemy, others threw away their arms, accoutrements, uniforms and everything that indicated that they were soldiers and fled to Valparaiso or scattered through the country; a few were taken prisoners. Very few of the Government wounded were brought into the hos-

pitals. That afternoon the bodies of Generals Barbosa and Alcerreca, half naked, were hauled through the streets of the city in a cart for the mob to gloat over. Fire and rapine held sway for a night and a day, all lawlessness being directed at the sympathizers or suspected sympathizers of the now fugitive President Balmaceda. A heavy rainstorm set in on the second night and dispersed the mob. This possibly saved the town.

The battlefield of La Placilla is not unlike that of Gettysburg reduced. Imagine Cemetery Hill a flat topped spur of a higher ridge in rear, the inclination on the top, however, being very slight, and Culp's Hill connecting with the same ridge, Cemetery Hill, however, to form the right of the position. Imagine that in place of bending the line back towards Culp's Hill, that it is placed nearly squarely toward the enemy. On the left imagine the line in the position near the Emmettsburg road, in place of being flanked by the equivalent of a Little Round Top, as it readily could have been by a natural bridge. The line of retreat, however, passed to the rear of the left, in place of to the rear of the right wing. Imagine, moreover, the left unassailable in front because of a great yawning gulf or succession of gulfs, which must divide the assailing party into two practically unconnected parts. The turning and driving in of the left would, ordinarily, simply make it stronger; one hundred men and two pieces of artillery with a few timely precautions in the way of intrenchments could ultimately have defied any assailants. But these men must be faithful to the cause. Treason meant not the defeat, but the rout of the betrayed, as it brought the assailants almost immediately upon the line of retreat of the main body who were well advanced to the front. It is known that Balmaceda's 2d Regiment of the Line went over to the Constitutionalists.

THE RAM IN ACTION AND IN ACCIDENT.

By W. LAIRD CLOWES, United States Naval Institute,* Fellow of King's College, London.

[*By Permission from the Journal of the Royal United Service Institution.*]

I have heard naval officers, of all ranks from the lowest to the highest, and in this theatre as well as elsewhere, express themselves in very sanguine tones concerning the future of the ram in naval warfare. I do not by any means intend to imply that all naval officers appear to believe to the same extent in the efficacy of this weapon. But I have known many, and among them officers of great experience at sea, who by their utterances suggest that, given slight superiority of speed and good handling, one ship can, without much difficulty, be made to ram another, even when the other is under full control and has plenty of sea-room in which to manœuvre. This view of the capabilities of the ram has always, though in a loose and vague kind of way, been widely held; and I venture to think that the number of those who hold it has increased of late, and especially since last June, when the country had to lament the terrible and dramatic fate of the Victoria, and of so many of her gallant officers and men.

It would be undue presumption on my part to evolve, as it were, from my inner consciousness, any opinions and theories as to the employment of the ram, and to put them forward here, before a meeting composed almost entirely of naval officers and practical men, as views worthy of serious consideration. But, recollecting as I do that naval officers and practical men have but little leisure for the study of the past, and that, nevertheless, they all agree

* Prize Essayist, 1892.

that the teachings of the past are of the utmost value to them, I am encouraged to lay before them a number of facts which I have assembled, and, with all deference, to indicate certain conclusions which those facts seem to force upon the mind of a very devoted, and I trust wholly unprejudiced, student of recent, as well as of ancient, naval history. I do not, in a word, ask you to listen to me, but to pay attention to the voice of events, which, though by-gone, have not ceased to be instructive.

The following is a detailed list of 74 cases of attempted ramming in what may be called modern naval warfare. I have included here all the cases, since the outbreak of the American War of Secession, on which I have been able to lay my hand. The list must not, therefore, be regarded as a list of selected examples. No doubt I have omitted some cases, but I have intentionally omitted none.

In the first column I have numbered the cases to facilitate future reference. In the second I have given the date. In the third I have specified whether the scene of the occurrence was in narrow waters (N.) where manœuvring was difficult if not impossible, or in some locality (S.) which afforded a reasonable amount of sea-room. In the fourth column is the name of the would-be rammer. In the fifth is the name of the craft which it was endeavored to ram. In the sixth column I have shown the condition of the would-be rammer after the manœuvre had been executed or had failed. By U., I mean that the ship was, so far as the operation was concerned, uninjured; by Da., that she received slight or moderate damage; by S. Da., that she received serious damage sufficient to greatly impair her immediate fighting powers; by R. A., that she missed her mark and ran ashore; and by S., that she sank in consequence of the collision. In the seventh column I have indicated whether the ship intended to be rammed was at that moment under steam (S.), at anchor (A.), or unmanageable, on account of accident either to her machinery or to her steering gear (Un.). In the eighth and last column I have noted the condition, in consequence of the attempt, of the vessel intended to be rammed; U. signifying uninjured; Da., slight or moderate damage; S.Da., serious damage; Di., disabled; and S., sunk.

PARTICULARS OF ATTEMPTS TO RAM IN ACTION, 1861–1879.

1.	2. Date.	3. Nature of locality.	4. Rammer.	5. Rammed.	6. Subsequent condition of rammer.	7. Previous situation of rammed.	8. Subsequent condition of rammed.
1	Oct. 11, 1861	N.	Manassas	Richmond	S. Da.	A.	Da.
2	Feb. 10, 1862	N.	Commodore Perry	Sea Bird	U.	A.	S.
3	Mar. 8, 1862	S.	Virginia	Cumberland	Da.	A.	S.
4	Mar. 9, 1862	S.	Monitor	Virginia	U.	S.	U.
5	Mar. 9, 1862	S.	Virginia	Monitor	Da.	S.	U.
6	Apr. 24, 1862	N.	Manassas	Pensacola	U.	S.	U.
7	Apr. 24, 1862	N.	Manassas	Mississippi	U.	S.	S. Da.
8	Apr. 24, 1862	N.	Manassas	Brooklyn	U.	S.	S. Da.
9	Apr. 24, 1862	N.	Governor Moore	Varuna	U.	S.	S. Da.
10	Apr. 24, 1862	N.	Stonewall Jackson	Varuna	U.	S.	S.
11	May 10, 1862	N.	General Bragg	Cincinnati	U.	S.	S. Da.
12	May 10, 1862	N.	General Price	Cincinnati	U.	S.	S.
13	May 10, 1862	N.	General van Dorn	Mound City	U.	S.	Di.
14	June 6, 1862	N.	Queen of the West	Lovell	U.	S.	S.
15	June 6, 1862	N.	Beauregard	Queen of the West	U.	S.	Di.
16	June 6, 1862	N.	Beauregard	Monarch	U.	S.	U.
17	June 6, 1862	N.	Price	Monarch	U.	S	U.
18	June 6, 1862	N.	Monarch	Beauregard	U.	S.	S.
19	July 18, 1862	N.	Arkansas	Carondelet	U.	S.	U.
20	July 22, 1862	N.	Essex	Arkansas	U.	A.	Da.
21	July 22, 1862	N.	Queen of the West	Arkansas	Da.	A.	Da.
22	Jan. 1, 1863	N.	Harriet Lane	Bayou City	Da.	S.	Da.
23	Jan. 1, 1863	N.	Neptune	Harriet Lane	S.	S.	Da.
24	Jan. 1, 1863	N.	Bayou City	Harriet Lane	Da.	S.	Da.
25	Jan. 31, 1863	S.	Keystone State	Palmetto State	Da.	S.	U.
26	Feb. 24, 1863	N.	Queen of the West	Indianola	U.	S.	Da.

PARTICULARS OF ATTEMPTS TO RAM IN ACTION, 1861–1879.—(*Continued*).

1.	2. Date.	3. Nature of locality.	4. Rammer.	5. Rammed.	6. Subsequent condition of rammer.	7. Previous situation of rammed.	8. Subsequent condition of rammed.
27	Feb. 24, 1863	N.	Webb	Indianola	Da.	S.	U.
28	Feb. 24, 1863	N.	Webb	Indianola	U.	S.	Da.
29	Feb. 24, 1863	N.	Queen of the West	Indianola	U.	S.	U.
30	Feb. 24, 1863	N.	Queen of the West	Indianola	U.	S.	U.
31	Feb. 24, 1863	N.	Queen of the West	Indianola	U.	S.	Da.
32	Feb. 24, 1863	N.	Webb	Indianola	U.	S.	S.
33	Oct. 7, 1863	N.	Wachusett	Florida	U.	S.	Da.
34	Nov. 9, 1863	S.	Niphon	Ella and Anne	Da.	A.	Da.
35	Apr. 18, 1864	N.	Albemarle	Miami	U.	S.	Da.
36	Apr. 18, 1864	N.	Albemarle	Southfield	U.	S.	S.
37	Apr. 18, 1864	N.	Albemarle	Miami	U.	S.	U.
38	May 5, 1864	N.	Sassacus	Albemarle	S. Da.	S.	Da.
39	May 5, 1864	N.	Albemarle	Matabesett	U.	S.	U.
40	Aug. 5, 1864	S.	Tennessee	Hartford	U.	S.	U.
41	Aug. 5, 1864	S.	Monongahela	Tennessee	U.	S.	U.
42	Aug. 5, 1864	S.	Ossipee	Tennessee	U.	S.	U.
43	Aug. 5, 1864	S.	Monongahela	Tennessee	Da.	S.	Da.
44	Aug. 5, 1864	S.	Lackawanna	Tennessee	Da.	S.	Da.
45	Aug. 5, 1864	S.	Hartford	Tennessee	U.	S.	U.
46	June 11, 1865	N.	Amazonas	Jeguy	U.	S.	S.
47	June 11, 1865	N.	Amazonas	Salto	Da.	S.	S.
48	June 11, 1865	N.	Amazonas	Marquez de Olinda	Da.	S.	S.
49	July 20, 1866	S.	Erz. Ferdinand Max	Re d'Italia	U.	S.	U.
50	July 20, 1866	S.	Erz. Ferdinand Max	Palestro	U.	S.	Da.
51	July 20, 1866	S.	Erz. Ferdinand Max	Re d'Italia	U.	Un.	S.
52	July 20, 1866	S.	Ancona	Erz. Ferdinand Max	U.	S.	U.

PARTICULARS OF ATTEMPTS TO RAM IN ACTION, 1861–1879.—(*Continued*).

1.	2. Date.	3. Nature of locality.	4. Rammer.	5. Rammed.	6 Subsequent condition of rammer.	7. Previous situation of rammed.	8. Subsequent condition of rammed.
53	July 20, 1866	S.	Kaiser	Re di Portogallo	S. Da.	S.	S. Da.
54	July 20, 1866	S.	Affondatore	Kaiser	U.	S.	U.
55	July 20, 1866	S.	Re di Portogallo	Schwarzenberg	U.	S.	U.
56	July 20, 1866	S.	Maria Pia	?	U.	S.	U.
57	Aug. 19, 1867	S.	Izzedin	Arcadion	U.	Un.	S. Da,
58	Nov. 9, 1869	S.	Bouvet	Meteor	U.	S.	Da.
59	May 29, 1877	S.	Huascar	Shah	U.	S.	U.
60	May 21, 1879	S.	Huascar	Esmeralda	U.	S.	U.
61	May 21, 1879	S.	Huascar	Esmeralda	U.	S.	U.
62	May 21, 1879	S.	Huascar	Esmeralda	Da.	Un.	S.
63	May 21, 1879	S.	Independencia	Covadonga	U.	S.	U.
64	May 21, 1879	S.	Independencia	Covadonga	U.	S.	U.
65	May 21, 1879	S.	Independencia	Covadonga	R. A.	S.	U.
66	July 10. 1879	S.	Huascar	Magellanes	U.	S.	U.
67	July 10, 1879	S.	Huascar	Magellanes	U.	S.	U.
68	July 10 1879	S.	Huascar	Magellanes	U.	S.	U.
69	July 10, 1879	S.	Huascar	Magellanes	U.	S.	U.
70	Oct. 8, 1879	S.	Huascar	Cochrane	U.	S.	U.
71	Oct. 8, 1879	S.	Cochrane	Huascar	U.	S.	U.
72	Oct. 8, 1879	S.	Cochrane	Huascar	U.	S.	U.
73	Oct. 8, 1879	S.	Huascar	Blanco Encalada	U.	S.	U.
74	Oct. 8, 1879	S.	Cochrane	Huascar	U.	Un.	U.

Before summarizing the results, I will add a few notes on some of these cases.

3.—The Virginia in this case wrenched off her ram, and so decreased her efficiency for the action of the following day.

4, 5.—The Virginia had a speed of about 5 knots only on this day. The Monitor was little faster.

15.—The Queen of the West was run ashore to avoid sinking.

20.—The Essex was very slow. The Arkansas, though fast by the stern, had cast off by the bows, and was able to swing her head round to meet the attack.

24.—The Bayou City was able to board and capture the Harriet Lane.

25.—There is some doubt as to whether the Keystone State's opponent was the Palmetto State or the Chicora. The Keystone State, on approaching, was damaged and practically turned off by shell-fire.

26.—The Indianola had a barge lashed on her port side. This was torn away and sunk.

27.—The Webb and Indianola rammed one another bows on. The former damaged the ram.

28.—The Indianola had a barge lashed on her starboard side. This was crushed and sunk.

31, 32.—These were practically simultaneous, the Queen of the West ramming on the starboard side, and the Webb astern.

33.—This occurred off Bahia in neutral waters. The Florida, struck on the starboard quarter. had her bulwarks cut down and her main and mizzen yards carried away, but was not actually disabled, although she surrendered.

34.—The Niphon, and the Ella and Anne, a blockade-runner, rammed one another bows on. The latter lost her bowsprit and stem, and was boarded and taken.

35, 36, 37.—The Miami and Southfield were lashed together, the former on the starboard side of the latter. In No. 35 the Miami was struck on the port bow. In No. 36 the Southfield was struck fair on the starboard bow, and tearing away, sank. In No. 37 the Miami, being free, escaped.

38.—The Sassacus, which was not adapted for ramming, struck squarely and at some speed just abaft the beam, but did more harm to herself than to her enemy.

43.—The Monongahela lost her ram.

50.—The Palestro lost her mizzen topmast and gaff with ensign.

51.—The Austrian official report says: "In the meantime it looked as if the Re d'Italia's helm had been shot away, for from this moment she lay isolated in the midst of several of the Imperial ironclads. . . . . Rear-Admiral von Tegethoff did not fail to note the critical situation of the Re d'Italia, whose movements, owing to the injury to her steering gear, were confined to backward and forward ones . . . . The Re d'Italia went ahead at full speed in order, if possible, to avoid the blow, or to weaken the force of it; but an Austrian ironclad barred her way. Then she went full speed astern." This shows I think, beyond question, that at the time of receiving the blow which immediately followed, she was not under control. The blow upset everyone who was below in the Erzherzog Ferdinand Max. The ram penetrated 6 ft. 6 in., the flag-ship having on her a speed of 11.5 knots. The Re d'Italia, which was struck on the port side, rolled 25° to starboard, then more heavily to port, and sank almost immediately in 200 fathoms.

53.—The Kaiser was a wooden line-of-battleship; the Re di Portogallo, an ironclad. The former, going at full speed, struck a slightly glancing blow on the beam. She lost her bowsprit, stem, foremast, and funnel, and was seriously hurt. The ironclad was also badly injured.

56.—The Maria Pia's opponent, which she failed to strike, was an Austrian wooden ship.

57.—Both vessels were iron paddle-steamers, the Izzedin having a speed of 15.5 and the Arcadion af 15 knots. The latter was not rammed until she had by gun-fire lost the use of one paddle. The blow so badly damaged her that she was run ashore and burnt to save her from capture.

58.—The Bouvet, capable of steaming at 11 knots, struck the Meteor, which could do only 6 knots, a glancing blow on the port bow at an angle of 5°, and rubbing along the port side, damaged the Meteor's upper works, and upset two guns which had been run out ready for firing.

60, 61, 62.—The Huascar on this occasion steamed at about 8 knots. According to the official American account ("Information

from Abroad. War Series, No. 11") she fired at the Esmeralda at least 40 shots from her two 300-pdrs. Of these only one struck the enemy, but that one passed through the side, burst in the engine-room, and killed every one of the engineers, besides disabling the engine. The fight was the most gallant one that has ever been waged in modern naval warfare. At the first collision, Captain Prat, followed by one man, boarded from the Esmeralda, which was nearly motionless by that time. Both were shot down on the Huascar's deck. At the second collision, Lieutenant Serrano, next in command, boarded and was also shot down. At the third collision, the little Chilian wooden sloop, old, rotten, unable to move, but still firing, went to the bottom with her colors flying.

65.—The Covadonga, an old gunboat, was incapable of doing 5 knots; the Independencia, an ironclad, could do nearly 12 knots. The Covadonga, nevertheless, avoided all three blows, and by good management so placed herself that, on the third occasion, the Independencia, missing her, and at the same moment losing her helmsman, went ashore, where she was burnt to save her from capture.

71, 72, 74.—These attempts all failed, although the Cochrane, at the beginning of the action, could steam 12 knots to the Huascar's 10. After 73, the Huascar became partially uncontrollable.

The following summaries of the results to would-be rammer and intended rammed in the above 74 examples are, I think, very suggestive.

The results, so far as the ships intended to be rammed, are concerned, were:—

Previous situation of the ship attempted to be rammed.	Total number of cases.	Effect upon the ship attempted to be rammed.				
		Nil.	Slightly damaged.	Seriously damaged.	Disabled.	Sunk.
Under steam with sea-room..............	32	26	5	1	..	..
Under steam in narrow waters.....	32	9	9	3	2	9
Unmanageable........	4	1	..	1	..	2
At anchor............	6	..	4	..	..	2
	74	36	18	5	2	13

The results, so far as the ships ramming are concerned, were :—

	Effect upon the ship attempting to ram.				
	Nil.	Slightly damaged.	Seriously damaged.	Disabled (run ashore).	Sunk.
Total number of cases, 74......	56	13	3	1	1

It will be observed that, in 42 out of the whole number of 74 cited attempts at ramming, damage of some kind or other was done to one or both ships. In 24 of these 42 cases of effectual collision, the ramming ship received no damage worth mentioning; but in seven cases the ramming ship did herself about as much harm as she did to her opponent; and in seven other cases she injured herself even more severely than she injured her enemy. In no case did both rammer and rammed sink.

All these cases occurred, of course, before the automobile torpedo had developed into anything like a perfect weapon, and most of them before the introduction of heavy breech-loading and light quick-firing guns. But, reasoning upon the conditions which ruled up to the end of 1879—since when, I believe, there have been no cases of ramming in action—and upon the experience of the 74 attempts which I have noticed, we may fairly say that the probable results, under the old state of affairs, of 100 efforts to ram, would have been thus distributed :—

A. If both ships had sea-room and were under control :

(Based on the 32 cases numbered 4, 5, 25, 34, 40 to 45, 49, 50, 52 to 56, 58 to 61, and 63 to 73.)

(1). Effect on the attacked :—

Sunk......................	0.000
Seriously damaged..........	3.125
More slightly damaged......	15.625
Uninjured..................	81.250
	100.000

(2). Effect on the attacker :—

Fatally injured (run ashore)...	3.125
Seriously damaged..........	3.125
More slightly damaged......	15.625
Uninjured..................	78.125
	100.000

B. If both ships were in narrow waters, but under control :—

(Based on the 32 cases numbered 6 to 19, 22 to 24, 26 to 32, 35 to 39, and 46 to 48.)

(1). Effect on the attacked :—

Sunk......................	28.125
Disabled..................	6.250
Seriously damaged..........	9.375
More slightly damaged......	28.125
Uninjured..................	28.125
	100.000

(2). Effect on the attacker :—

Sunk......................	3.125
Seriously damaged..........	3.125
More slightly damaged......	15.625
Uninjured..................	78.125
	100.000

The obvious conclusions are somewhat remarkable. One is that, if two ships have sea-room and be fully under control, it is actually more dangerous to try to employ than to try to escape the ram, and that, under these conditions, it is practically hopeless to dream of ramming effectively, since there is no recorded case of the operation having been performed, although it has been attempted at least 32 times. Another is that, in such circumstances, the rammer stands about the same chance as the rammed does of sustaining non-fatal injuries. Another is that the risks attendant upon ramming are the same whether the attempt be made at sea or in narrow waters. The exact similarity of *A* (2) and *B* (2) is,

indeed, extraordinary. I do not know that any of these conclusions have ever before been called attention to.

To what extent, it may be pertinent to ask, has the value of the ram as an offensive weapon been modified by the progress of the last 15 years? Will captains be more willing, or will they be less willing, to use it, now, when the nearer they approach to the foe the more fatal will be the foe's quick-firing artillery, and when, at any range up to 800 yards, the effects of a torpedo are to be feared? And why should captains attempt to employ the ram at all, when a torpedo, which is far less easy to avoid, and the use of which involves little or no risk to the user, will do all that is necessary? It may be granted that, having first disabled his enemy by gun-fire, a captain may ram with a reasonable probability of success; but, in doing so he not only risks damaging his own ship, encountering torpedoes, and bringing about needless loss of life, but adopts a course that leaves comparatively little chance that the enemy, which by other action might be reduced and taken, will ever be added to the effective sea-forces of his own country. And, after all, a triumph is only half a triumph unless there be something to show for it. One of the few things that would go towards reconciling Great Britain to the agonies of a naval war would be the occasional spectacle of a foreign battleship brought into Spithead, or Plymouth Sound, with the white ensign blowing out above the other flag. That is a sight which would animate the whole Empire, even in its hours of misery. If only on these grounds, it seems unwise to destroy your foe when peradventure you can take him alive. And it is scarcely conceivable that a disabled vessel cannot be reduced and made to strike by the combined influence of gun-fire and the threat of the torpedo.

I have cited 74 examples of the intentional employment of the ram. In those cases it has, in one way or another, brought about the loss of 15 ships only, including those which perished by their own act. But the ram unintentionally employed, both in action and in peace-time, has, I am afraid, been much more fatal. I am not going to trouble you with another long list and with more statistics. I will only recall the damage it has wrought in the case of the Iron Duke and the Vanguard, the König Wilhelm and the Grosser Kurfürst, the Camperdown and the Victoria, the Osprey and the Amazon, the Ajax and the Devastation, and many more,

in peace-time; and mention two or three examples of its dangerous effect upon friends in action. At the battle of Memphis, on June 6, 1862, the Confederate vessels Beauregard and Price unintentionally rammed one another, and the latter had to run ashore to avoid sinking. At the Battle of Mobile, on August 5, 1864, the Lackawanna unintentionally rammed, and very nearly sank, her consort, the Hartford, Admiral Farragut's flag-ship, and soon afterwards the Ossipee was unable to avoid ramming the Tennessee after the latter had surrendered. Again, on the great day of Lissa, the Ancona accidentally rammed her consort, the Varese, and the San Martino her consort, the Maria Pia. The Ancona and Maria Pia received only slight damage, but the San Martino had her ram twisted and sprang a leak.

To my mind, if I may intrude an opinion by way of making an end, the main lessons of the past on the subject indicate, firstly, that to endeavor to effectively ram a ship that has sea-room and that is under control is hopeless, even if she be of greatly inferior speed; secondly, that a vessel that cannot be sacrificed ought never to be deliberately employed as a ram; and, thirdly, that for ramming purposes a little ship is quite as good as a big one. Whether or not this last deduction points to the fact that, with a view to certain eventualities, this country would do well to build a few fast small craft intended for ramming only, and of no particular value, I will not presume to say. But upon that point I am specially desirous to learn the views of those who are competent to speak about it.

Vice-Admiral NICHOLSON :—Mr. Chairman, I venture to make a few remarks on the most interesting paper that has just been read to us. We must all have been surprised at the result of the figures which have been brought out by Mr. Laird Clowes. No doubt the lesson will be most instructive; but I think there are some very important matters to be discussed in connection with the question of ramming, and I hope to hear the opinions of those who are better fitted to express them than myself. It appears to me that whether the ram is a very efficient weapon or not is outside the question. Our lecturer says "naval officers" are very hopeful about it in action. It is not, however, only the naval officers who are very hopeful, but also the rulers of the Navy and naval constructors, because we see every ship of any structural strength fitted with one of these rams, and evidently they would not have been so fitted if they had not been intended to be used. Therefore, we, as naval officers, have to consider this ques-

tion : Having these rams given us as a means of offense, and consequently being bound to develop their legitimate use, as well as that of torpedoes and guns, what relative value should we attach to them ? The question is, having a very powerful ship provided with different means of offense, are we, in the first place, to avail ourselves of the ram, the torpedo, or gun? Of course there can be no question whatever that the ram must be looked upon as the last resource. I do not think any one would be so mad as to attempt to use his ram early in action, and I doubt very much whether in a single action, in spite of all that has been said in this theatre on the subject, the ram would ever be efficiently used, except to deliver the *coup de grace*. But there are other conditions in which a ram might be used with great effect. Take the case of a general action ; to use sporting *parlance*, one or two rounds having been fought out, everybody knows the confusion which would ensue. At Lissa there were seven intentional attempts to ram and a very large number of unintentional collisions. Suddenly an enemy's ship shoots out from amidst the thick smoke, and is crossing your bow with her whole broadside bearing on you. There is now only one thing that can be done ; you cannot stop, you cannot go astern, and you had better harden your heart and use the ram. I think it is under such conditions of confused action that, probably, the ram will develop its greatest use—I mean during the sudden and unforeseen emergencies of a general action. The perfection of the torpedo is so great, and the gun-fire so terrific, that, beyond these accidental occasions, I do not think ram power would be a very efficient or powerful quality to possess, and certainly it would be a hazardous one to use. The point that I wish, then, with all modesty, to press upon my brother officers is this : Whether in the light of what has happened of late years they are content with the construction of the rams of our ships ? We all know the lamentable instance of the loss of the Victoria. What happened ? The ships were not going at a great speed, but the Camperdown only escaped by the skin of her teeth. Then, shortly afterwards, a second-class cruiser, the Forth, a ship of 4000 tons, coming up channel on a foggy day, presumably not at an excessive speed, accidentally collides with an empty collier. What would naval officers imagine should be the result of such a collision ? Surely that the second-class cruiser of 4000 tons would have gone through the empty collier like a knife through a pat of butter ! But what happened? The Forth had to go into Plymouth with her bows very seriously damaged. Surely there must be something wrong ! And the three points I wish to suggest to the meeting are these : First, whether it is not possible that the rams of ships should be constructed of such material and with such skill that they should be capable of sustaining one of these heavy blows given in actual warfare without material damage ; secondly, if this is not possible, would it not be wiser that the rams should be fitted not as a part of the main construction of the ship, so that if you come into collision, and your ram unfortunately is broken, still the main structure shall remain

intact? And the third point I would raise is this: If it is considered desirable that these precautions should be taken in ships that are to be constructed, is it not as desirable that the whole question should be most seriously considered, and, if possible, the rams of ships already built should be strengthened, so that officers, when they feel bound to use this weapon, shall not at the same time fear that they are incurring the risk of sacrificing the ships which the country has placed in their charge?

Lieutenant W. BADEN POWELL :—I should like to make one remark with regard to what Admiral Nicholson has put before the meeting, "that the ram, when it has done its work, if damaged, might drop off free of the ship." I think there would be a very grave danger to the ship with regard to that ram if it did not drop off, because if there was any angle on the blow in striking the other ship, the ram might get knocked to port or starboard, and though it might do its own work it would leave that ship with practically a bow rudder hard over, and she would do nothing but circle after that until she had been got into dry dock. So that, I think, the only way to look at the ram after the experience of the loss of the Victoria, and the damage to the Camperdown, is to see that it is sufficiently well constructed not to part from the ship, not to twist, and not to damage the ship on impact with the vessel she is intended to ram. I have had, since I have been on shore, very considerable experience in the Admiralty Court with what we may hope is unintentional ramming. The whole of the work in which I have been engaged has been collisions, and we have hundreds of collisions every year, in which merchant ships and some men-of-war unfortunately touch other ships, and with their stems. In nearly every case those mercantile ships are not constructed in any way with the intention of ramming, but they are all constructed with the anticipation of some day perhaps hitting a dock wall or a ship, and thereby damaging themselves to such an extent that they may be in danger of sinking. They are one and all now constructed with most efficient water-tight bulkheads, forming a collision compartment, and I may say, without exaggeration, that every year produces hundreds of ships—Lloyd's would be able to give the exact statistics—which, after serious ramming, are able to get to port, even hundreds of miles, though their bows are completely crushed out of all shape, simply by virtue of that strong collision bulk-head, which prevents the water from getting any further into the ship. I can only say, with due deference to the gentlemen who at the Admiralty and in ship-yards design vessels, that I think it is not "quite up to date" that Her Majesty's ships, like the Camperdown, should suffer so enormously from what I call a very mild impact with the Victoria. If the Camperdown had been going at full speed and had struck the broadside of the Victoria crossing at full speed, would not the damage have extended a great deal further aft, on one bow or perhaps both; and is it not also especially likely that the Camperdown would have been lost at the same time as the Victoria? I think when there is any settled

intention of using the ram it should be the naval architect's first principle to see that the structure of the bow of the ship, either by bulkheads and stringers, or by a kind of side longitudinal strengthening outside of the ship in the nature of ridges, should be so strong that nothing on earth or on the water should turn or twist that ram, or do damage to the bow affecting the safety of the ship. I think until this principle has been thoroughly well introduced into the construction of the ships of the service, captains will, as has been said by the lecturer and by Admiral Nicholson, use the ram as simply the last chance; so that I think it is purely a question of ship construction for the future as to whether the ram is to be relied upon —indeed if it is to be used at all.*

Captain CURTIS :—I should like to say a word or two upon what Lieut. Baden Powell has said. In the Crimean War the Recruit went from Malta to Corfu with a double rudder, a rudder at each end, but the rudder was not locked at the bows; apparently it never turned the ship from her course, as it was not discovered until they anchored at Corfu.† I think that proves that the bow rudder would have very little effect on the vessel going ahead. I have always understood that the greater the velocity with which you strike a body the better it is for the striking body. You remember the old experiment of firing a candle through a barn door, and we all see in railway collisions that when a train is going at a tremendous speed it suffers less than if it is going at a small speed. I have no doubt there are gentlemen here who have been to school later than myself, and they know all about the theory of forces.

Admiral BOYS :—It seems that our young members are somewhat bashful in giving us their views on this important subject. Therefore, although I am an old one, I rise to say a word or two. With respect to the Camperdown,—I happen to know something about the Camperdown, having had a son in her at the time of the collision, and we have corresponded on the subject. It is generally thought that the Camperdown was in great

* Generally the discussion appears to treat the matter as a question of merely a dual action between two ships; but the ram and the bow construction fit to rely upon must be capable of repeating the ramming dose to other ships of the enemy. With the nearest dry dock perhaps six or more days distant, the bow construction must be above suspicion, otherwise the ram will never be used, at least while a shot remains in the locker. In such case the ram bow, which is the worst form of bow for meeting a head sea at speed, may well be given up altogether.

† Relative to the Recruit, I receive the information from the navigating officer. In the year 1861 the late Mr. Laird, of Birkenhead, was of the opinion that the bean-cod bow or stem, such as the Lisbon boats have, was the best form for a ram bow. He fitted the Birkenhead ferry-boats with such stems, and he remarked that nothing can come near the upper works. What is required is to crush the side in, not to pierce a hole and get jammed in the ribs of the ship.—J. D. C.

danger of following the Victoria to the bottom from the effect of the collision, and so she was. But it was not from the damage done to her own ram; *that* was uninjured, the damage was all above the ram, and it was because the water-tight doors were not closed that the ship was in danger. If the water-tight doors had been closed in time, as they would have been "in action," there would have been comparatively but little risk in the Camperdown, beyond the filling of the foremost compartments. With regard to the removable ram that has been referred to, I do not think such an arrangement practicable, it would never stand a collision, and would weaken a ship where she should be strongest.

The CHAIRMAN (Admiral Sir R. Vesey Hamilton):—I think with regard to what Admiral Nicholson said, we have an every-day illustration of it in every regatta, that is, the galley and punt race. The difficulty of the galley catching the punt is very great, in fact it is almost an impossibility if the punt is properly handled. Therefore the short ship has a very great advantage. The fact that the ram of a big ship like the Forth should be wrenched off by a little collier shows something very radically wrong in the construction of rams of the present day. I myself have always thought so, and I believe that we cannot have a better ram than a straight up and down stem, which is quite sufficient for all practical purposes. There is very little fear of any damage being done to the ramming ship under such conditions. I entirely agree with what Mr. Baden Powell said, especially as to the water-tight doors and the collision bulkheads, and no better instance is within my own recollection than the case of the Arizona, which, when going 15 knots, ran into an iceberg, and backed off perfectly uninjured abaft the collision bulkhead. Had she been going at 8 knots instead of 15, she would have been racked. In this case, as in gunnery, the element of time is a consideration, even if it be only a fractional part of a second, and the Arizona was saved by her great speed. The moral is, if ever you are ramming another ship go at full speed, the greatest speed you can put on. Although of course I have heard of the candle and the barn door, I have never come across anybody yet who has tried it.

Captain CURTIS:—I tried it last summer.

The CHAIRMAN:—One has very often heard of it, but you are the first person that I have ever come across who has actually seen it tried. In that case it is precisely the same thing as the Arizona. It is the great speed that carries it through, but if you took up a candle and dashed it on the table, it would simply go to smithereens. The result of the table drawn up by Mr. Clowes we must all agree is very curious, and has opened our eyes a great deal. There is one illustration as to the Albemarle, which was uninjured. Some years ago I read a paper in this Institution on the result of the American Civil War. There was this very curious fact. The Albemarle was an improvised ram, armed with two guns. She was attacked by eight wooden vessels, which were especially ordered to ram her, and to try to run her down. The Albemarle had one

gun disabled in the early part of the day, and she fought the whole action with one gun, and although she was repeatedly rammed by eight vessels, and they tried to circle nets round her to foul her screw, she yet gained a glorious victory, and went back without losing a man. What the Northern loss was I do not know, but Boynton, the historian, says, "many killed, wounded, and scalded." The conclusion the lecturer comes to is, that if two ships do ram it is certainly more dangerous to be the rammer than those rammed. In my own opinion he would be a very bold man who would try to ram a ship unless he was perfectly certain that her torpedoes were all fired. It is one great value of the torpedo that it acts as an anti-rammer. None of us would like to go near a ship that has a torpedo, because before you get within ramming distance you might be blown up. This is a great comfort to those who have to fight in ships, and though I shall not have to do it, it will no doubt be a comfort to those who may. Then of course there is the question as to whether we should not try to capture the enemy rather than sink her. I believe there would be nothing that would stir up the martial feeling of this country more than the sight of a captured enemy, for although we may be a nation of shopkeepers, still there is a good deal of fight in us when occasion arises.

Mr. Arnold Forster, M. P. :—I should like to be allowed to say one or two words on this matter, as it does not appear that, at this stage of the discussion, I should be standing in the way of any naval officer. I have read the figures of the lecturer, and I confess I am not quite clear as to what are the conclusions arrived at; as to whether it is safe or unsafe to ram. Mr. Clowes concludes the paper with a recommendation in which I should most respectfully concur, that, ramming, to be an efficient operation of war, should be confined, as far as possible, to specially designed ships. But I am not convinced by his figures that the conclusion is unfavorable to the ram, because I observe in the table he gives that, in as many as 70 per cent. of the cases of ramming ships within confined waters, the rammed ship has been more or less seriously damaged. Of course I am familiar with many of the cases cited, though not with all, and a great number are cases of wooden ships; and, certainly from the information I have received, I am convinced that the problem of a wooden ship being rammed is a totally different one from that presented by the case of an iron ship when she is rammed. The question as to which ship is going to be damaged is much more difficult when you come to look into it than appears on the surface. I have lately been trying to get the opinion of scientific mathematicians as to what ought mathematically to be the result of one heavy ship ramming another at full speed. I have propounded the problem, and have never yet had an absolute, definite reply as to what the answer ought to be. Of course the question is complicated, as I was told the other day, by facts which only a practiced shipbuilder can supply, as to the question of the resistance offered by the particular class of materials which are opposed to the impact of the ram. If you are

dealing with two solid bodies, you can work out the thing mathematically without reference to any other formula at all, and you can get a positive conclusion. But certainly as far as my researches have gone into cases of modern ramming, under conditions anything like those which may probably occur in war, the record against the ram is not so serious as the lecturer would have us suppose. I remember seeing a photograph of the bow of the Arizona, and certainly nothing could be a more perfect illustration of what might happen to a ram of a ship than that was. I do not suppose you can imagine a more immobile body than an iceberg. The Arizona charged the iceberg at 15 knots. The bow was smashed in, and the mild steel plates drawn and damaged, but still that ship went 700 miles and was docked, I believe, at Halifax. She was certainly not incapable of steaming, or, I suppose, of taking part in an action if she had been a man-of-war. I also saw the Northampton after she had been rammed in the Channel by a sailing barque. The sailing barque went off scot free. I saw the side of the Northampton, and you could drive a cart through it; at any rate, the rent was high enough for that. The blow was arrested by the armor plating; the scroll work on the figure-head of the barque came right on board of the Northampton. In the case of ships which have been sunk like the Grosser Kurfürst and the Vanguard, the same lesson is taught. These are most marked cases of one ship ramming another with no damage, or practically none, to the ramming ship. Then there is the case of the Bellerophon, by the mere touch of the ram, sinking a steamer off the North American coast. Of course the case of the Forth may be quoted as an example on the other side. What I believe was the case was this: the Forth is not constructed in any sense as a ram, and could not be considered to be a ram in the proper sense. As a matter of fact, she struck the steamer at the joining of two compartments—I am not sure if that is the case, but I believe so—and no doubt much damage was inflicted by the strain; but I do not know if it is considered that that solves the problem presented by a properly constructed ship adapted for the purposes of ramming. Ramming is no new thing. The warships of ancient times were properly constructed rams; the Roman ships, and, at a later date, the Venetian galleys, were properly provided with rams, and we have never had any reason to doubt that in those ancient actions the successful blow of the ram was absolutely fatal to the ship rammed. That was because the ram was properly constructed. The case of the Camperdown has been mentioned. I took some pains to follow out the contours of the ram of the Camperdown, and I certainly can bear out the fact that the damage to the Camperdown was not damage done to the ram. If you followed the contours of the Camperdown and Victoria, you would see structurally it was impossible that what happened could have been avoided, namely, that the Camperdown striking the Victoria should not strike her with her ram only, but, following the line of the ship underneath the stem of the Camperdown, should come in contact with

the armor plate and the heavy deck plating of the Victoria. The wrench was chiefly inflicted upon the upper parts of the Camperdown, and was not in any way damage to the ram itself. A very remarkable case of ramming, on a very small scale, occurred the other day at Portsmouth harbor, and almost at the same time I heard Sir Edward Harland speak of the particular form given to our torpedo-boats, I mean the ram-shaped bow. I believe that that form has now been condemned. He said how ludicrous it is to suppose that a torpedo-boat should inflict any damage upon a sea-going ship. I do not believe myself that they were intended for that purpose; but it was curious that only the other day the Trafalgar was accidentally rammed by a torpedo-boat, and that that sharp snout did go right through the thin plate of the Trafalgar, so that the Trafalgar had to go into dock, and would have been actually unable to take part in an action. Certainly the result of my observation is that the ram is not necessarily a dangerous weapon to the ship which carries it. The other day I saw a photograph of the Achilles, which was rammed in the Mediterranean accidentally, and certainly there was a sharp, clean-cut hole in the side of that ship which would effectually have put her out of action, but there was no corresponding danger to the ship ramming. Then we come to the question whether it is advisable for any captain to use his ram in preference to any other weapon. There, of course, I have a very humble opinion, but it does seem to me, and what was said by the lecturer confirms my view, that where we have great ships costing enormous sums of money, with powerful armaments and heavy armor, it would be madness for the commanding officer to attempt at the outset of an action, or at any period of an action, if his opponent were not disabled, to use his ram. And for this reason, that the use of the ram involves the fact that you are within effective torpedo range. You spend a million sterling upon a ship which can be destroyed, and if struck will most certainly be destroyed, by a torpedo the moment she comes within 600 yards. Every advantage that you give to that ship, of speed, armory, discipline, gunnery, is neutralized in a moment if she comes within 500 yards of a Thames tug, just as surely as if it is a ship of her own size and strength, provided that the tug successfully discharges a Whitehead torpedo. Therefore it does seem to me that no powerful ship should ever, except in the last resource, think of using the ram. But that does not remove from our consideration the question as to whether or not it would be wise to fit ships specially for the purpose of carrying rams. Certainly my opinion, guided by what I have read and heard, is very strongly to the effect that there might be a very great advantage in fitting ships on purpose to carry the ram. I am very familiar indeed with the Polyphemus, and how she has served during her three commissions. I would not say that the Polyphemus is the last word in the creation of ships of her class, but I think no naval officer would hesitate for a moment to say that ships presenting a comparatively small target to gun-fire and structurally designed

so as to be able to carry the ram with the greatest possible effect, having a high speed, and only taking part when their services would be likely to be effective, would not be about the most formidable engines of war that could be conceived, because, after all, granting that the ramming ship be not sunk, and even granting she is, it is absolutely the fact that a fairly delivered blow from a ram is destruction to a ship-of-war. Therefore I should support the lecturer's view in so far as he holds us to that, and I believe that the ram ought not to be discarded as a naval weapon, provided it is used by naval officers in the best and most scientific way; but I should have a great objection to any encouragement being given to use our costly vessels for the purpose of ramming, for which purposes in their present form they are not designed.

Mr. E. RUPERT HICKS:—With regard to the question of ramming, I certainly am of opinion, with the last speaker, that vessels should be specially constructed for that purpose, and especially that they should meet the requirements spoken of. In the case of the Camperdown, the damage caused by the accident which happened to her bows and deck would not have occurred, in my opinion, had there been a solid steel cutting piece across the vessel's bows, to catch the second blow.

Admiral BOYS:—May I add one word with respect to something that has fallen from Mr. Arnold Forster, which I should not like to go forth to the public from this Institution as he has put it? I think he intimated that if a vessel was struck by a torpedo she must necessarily be destroyed. I do not agree with that at all. Having had some experimental experience with torpedoes my opinion is, it does not follow at all that a large vessel struck by a torpedo, or more than one, must necessarily be utterly destroyed.

Mr. ARNOLD FORSTER:—What I wished to point out was that a large ship may be destroyed by a smaller ship, and that the torpedo discharged by a small ship is equally effective with the same weapon discharged by a large ship. If I put the matter more strongly than that I admit I somewhat overstated it.

Lieut. W. C. CRUTCHLEY, R. N. R.:—Sir, will you permit me to say that from the lecture, admirable though it be, there appears to be an impression that superior speed will not give you the power of ramming a slower ship? The contention has been mainly on the supposition that two vessels of unequal size are opposed to one another, but before any fair conclusion can be drawn vessels of equal size and handiness must be opposed to one another, when superior speed would give the advantage. For two vessels to run at one another end on to ram, would show as much skill in fighting as two goats in a field. The ram as a weapon would be used as a last resource, and then I think superiority of speed would be everything.

Major BLACKER:—With regard to the question of the torpedo it has been stated that the fear of being struck by a torpedo will prevent a ship from ramming another. Is there any fear, on the other hand, that the

torpedo might explode in the tube through a shot striking it and actually damage the ship using it? Only submerged tubes could thus be used, and they cannot always be trained in the required direction.

Commander BERKELEY, R. N.:—As you have called upon junior officers, I should not like the appeal to be altogether unresponded to. There is one thing I think that has not been mentioned. I believe about the safest position in which a ship can go when she is likely to be attacked by a torpedo is full speed at her enemy. I have seen it tried, some years ago, on the Polyphemus. I believe I am right in saying that she was steaming about seven knots? A torpedo was fired within three lines on her bow—I think two of them—and both glanced off within a very few feet, being turned aside by the bow wave. Therefore it seems to me the best thing we can do is to go full speed at the enemy, using our gun-fire, and, if opportunity serves, our torpedo, but let us go at them with the ram by all means. The question, of course, is whether we can depend upon our weapon, and for that we must trust to the contractors and not to ourselves.

Mr. LAIRD CLOWES:—When was the experiment with the Polyphemus that you were speaking of?

Commander BERKELEY:—It was in 1886.

The CHAIRMAN (Sir Vesey Hamilton):—You mean to say the torpedo did not touch the vessel at all, but the bow wave glanced it off?

Commander BERKELEY:—Exactly. The torpedoes glanced off on each side.

Mr. LAIRD CLOWES, in reply, said:—I am very sorry that there has not been so much discussion as I could have desired. I am afraid that it is because I have restrained myself in expressing my opinions, but I intend to express them now very definitely indeed. Admiral Nicholson made some very instructive and suggestive remarks. He spoke of the universal application of rams to battleships. It is an interesting fact in connection with this subject that the latest French battleship to be completed, the Brennus, has no ram. She has a straight-up-and-down bow. The case of the Forth has been cited as tending to certain conclusions. Now, I purposed, when I put a title to this paper, to consider in detail the effect on the rammer and rammee of the ram in accident as well as in action, but I found that it would have taken far too long, and that I should not have been able to deal with the subject for want of time. I saw the other day at Toulon a very curious case in the action on the rammer of involuntary ramming. It was that of the French cruiser Cécille. She has, of course, no ram, except in the sense that the Forth has been said to possess one. She has merely a ram-shaped bow, exaggerated into an "*avant à plage*" as the French call it. She had rammed a merchant ship and the collision had the most extraordinary effect upon her bow. The whole was twisted nearly at right angles to port, yet nothing had given way except the rivets. It was a most extraordinary piece of good workmanship; the plates were all intact, but nearly every rivet had been torn

away. It is useless to cite the case of men-of-war ramming merchant ships, or of merchant ships ramming icebergs, as having any real bearing upon the question of the employment of the ram in warfare, because, as the unfortunate case of the Camperdown *vs.* Victoria shows, a great deal of the damage which is done in such cases to the rammer is done by the knife-like action of the armored deck of the rammee, and neither icebergs nor merchant steamers have armored decks. As for dropping rams, I do not know whether it has ever been attempted to build a ship with a ram which could be dropped at sea without injury to the parent structure. The Shannon has a detachable but not a dropping ram. But in the case of the Merrimac that vessel did lose her ram, and she did not thereby so much weaken herself as to restrain herself next day from preparing to ram the Monitor with her unarmored bow. Several speakers seem to think it a question of strength and construction whether the ram should be used or not.

I will point out later what my conclusions are, but I thought that, if I had dwelt upon any conclusion at all, it was upon the fact that, whether you have a strong or weak ram, you cannot effectually use it as long as the enemy has sea room, and is under full command. Whether the straight up-and-down stem, even if it were made so strong as to justify a ship in ramming with it, would suffer less than the sharp ram I do not know. I should think that it would not suffer any less, because, as a rule, the "tumbling-home" line of the bows of a modern ship is continued far above the waterline, and therefore the tendency of it is to wrench up and lift the armored deck of the rammed ship, and so, while intensifying the injuries of the enemy, to minimize the cutting effect of his deck. If you had a straight up-and-down bow it would not have any effect of that kind on the armored deck, which would cut the stem nearly at right angles, and not be deflected upwards. I think that the question as to whether the ram ought to be delivered at reduced or at full speed is one which deserves a great deal of consideration. I believe in the case of the Erzherzog Ferdinand Max that the ship did ram at full speed, and that the speed was not actually reduced until the moment of collision. There is now rising up in the British Navy a school which would ram at full speed, although, only two or three years ago, if in this theatre the question of ramming at full speed had been put forward, nobody would have spoken in favor of it.

The importance of ramming at least at fair speed was shown in the case of the action of the Huascar with the Esmeralda. The Esmeralda had practically no speed at all and could not run away, but the captain of the Huascar was anxious to save his own vessel, and he tried to ram with a speed of only 3 knots. On two occasions, although the Esmeralda was barely able to move, she avoided the blow, and at last, when the captain of the Huascar did ram, he had to ram at speed. Mr. Arnold Forster wants my conclusions, and I shall give them. He says that he does not agree with my percentages and cites against them cases of accidental

ramming. I do not think that you can lump the two classes of cases together. In the case of accidental ramming the conditions are different on the side of the rammer as well as on that of the rammee. Mr. Forster tells us that, in the case of accidental ramming, it is an unusual thing for the rammer, being a battleship, to do herself much harm, but we should bear in mind that in these cases of accidental ramming it generally happens that, althought there is sufficient to produce damage to the rammed ship, the blow is delivered at such slight speed and in such circumstances that one would hardly expect that a specially-prepared ship should do herself any considerable damage. In action, however, attempted ramming must be at great speed or it will be almost impossible to attain any success at all. The question of superior speed has been dealt with by several speakers as something which will enable you to ram your enemy. No doubt in theory it should do so, and if one ship be running away, and the other ship, having superior speed, be coming rapidly up, you would expect the latter to be able to ram, but practice shows that it is almost impossible unless the first causes the other vessel to lose control of herself, or unless the ships be in confined waters, which comes to much the same thing. An observation made by Captain Berkeley about the Polyphemus reminds me that I was present in 1885, when a similar kind of experiment was tried. My recollection is that the torpedoes were not fired from any point ahead of the Polyphemus, but from each side as she entered Berehaven. The torpedoes were deflected by her bow wave, but, of course, the operation of the bow wave on a torpedo coming at right angles to the ship would be different from that on one coming up head on ; and, beyond all manner of doubt, the torpedo of the present day is very different from the torpedo of 1885. One point which I wonder has not been called attention to is this : What is going to be the result of your ramming if you happen to have a live torpedo in you bow tube at the time ? It seems to me that there again is a point that is worth consideration.

My general conclusions, so far as I can hastily formulate them, would be these :—1. That attempted ramming is not dangerous to a rammee when there is sea room, and when the ship is under control. 2. That attempted ramming is always dangerous to the rammer—I mean in action —but, as a rule, only dangerous to the rammee where ships are in narrow waters or where the rammee is not under control. But, even where the rammee is not under control, ramming, besides being dangerous to the rammer, is really unnecessary, since there are generally other ways of dealing with a ship that can neither steer nor steam. She ought certainly to be made a prize.

The next conclusion would be that, since in accidental ramming the ram is notoriously dangerous, and since in cases of intentional ramming it has been shown to be not nearly so dangerous, therefore the ram (or, at least, the projecting ram) as a weapon is more dangerous to friend than foe, and might advantageously be got rid of.

My fourth conclusion would be that superiority of speed will not give success to attempted ramming. With regard to the construction of vessels specially with a view to ramming I have not intended to express any opinion. I hoped to have obtained an expression of opinion from the meeting. But it is necessary to bear in mind that vessels are built abroad especially for the purpose and for nothing else.. Whether vessels like the Katahdin, which steams at a speed of only 17 knots, will be able to do much ramming I very much doubt; but still, other Powers are building vessels for this purpose, and it is a question which we ought to consider in this country. I thank you very much for the attention which you have paid to me.

The CHAIRMAN (Sir Vesey Hamilton):—I am sure you will agree in according a vote of thanks to Mr. Laird Clowes for his admirable lecture, and the great trouble he has taken in drawing up these tabulated statements with regard to the results of ramming. I do not think any one had any idea that there were so many cases as he has tabulated.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

NOTES ON THE LITERATURE OF EXPLOSIVES.*

BY CHARLES E. MUNROE.

No. XXV.

Under the title "Modern Gunpowder Tests," A. Tenner gives in the *Amer. Field*, 40, 527-530, 552-555, 576-577, 600-601, Dec. 1893, the results of tests which were recently conducted at Chicago and at the DuPont Works at Carney's Point, N. J., and which had for their object the determination of the relative merits of several of the "nitro-powders," now in the market or recently offered for use, when fired from shot guns of various kinds, in comparison with certain well known black sporting powders.

The qualities especially tested, upon which the relative values of the powders were believed to depend, are enumerated in the following table, the maximum weights assigned to each being placed opposite.

QUALITIES AND POINTS OF MERIT.

Qualities.	Points of Merit.
1. Comparative lowest bursting strain	30
2. Uniformity of bursting strain	15
3. Highest velocity (penetration)	20
4. Uniformity of velocities	14
5. Best pattern with a sufficient corresponding velocity	25
6. Uniformity of pattern if accompanied by sufficient velocity.	14
7. Non-susceptibility to moisture	15

*As it is proposed to continue these notes from time to time, authors, publishers and manufacturers will do the writer a favor by sending him copies of their papers, publications or trade circulars. *Address, Columbian University, Washington, D. C.*

	Quantities.	Points of Merit.
8.	Non-susceptibility to dry heat	15
9.	Least fouling of barrels	8
10.	Least recoil	8
11.	Least smoke	8
12.	Least heating of barrels	5
13.	Least liability of causing a corrosion of gun barrel	15
14.	Least degree of reaction to highly increased charges	8

The values as assigned the powders tested are exhibited in the next table, the numbers at the head of each column conforming to that for qualities in the preceding table.

POINTS OF MERIT AS AWARDED TO EACH POWDER.

Powder.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total	Order
American Wood	29	12	16	11	23	13	12	0	13	6	6	4	5	4	154	5
S. S.	26	10	18	10	22	14	12	4	9	7	6	6	5	4	153	8
DuPont's smokeless	18	6	19	11	24	11	12	5	11	8	8	8	4	5	150	9
Schultze	24	10	18	10	23	10	14	5	9	7	6	6	8	4	154	5
Schultze, Pompton	24	8	20	9	23	14	14	5	8	7	6	6	7	4	154	5
DuPont's black	30	14	20	11	21	10	15	11	13	1	3	0	8	2	159	4
E. C.	28	11	18	13	25	11	14	7	11	6	6	6	6	4	166	3
Walsrode, leaf	26	13	17	14	21	14	17	15	15	8	6	6	6	4	172	2
Walsrode, grain	26	14	18	14	25	11	11	14	13	8	8	8	5	5	180	1

The velocities were determined in the ordinary way at 40 yards, with the Boulengé chronograph. The Hahn spring pressure gauge was used for chamber pressures. The author claims that recoil is better calculated from "several formulas," than determined by experimental observation, and hence he has employed the former method but he fails to give these formulas or the data used.

The hygroscopic properties of the powders were tested by exposing them in open dishes for twenty-four hours in a cellar where the relative humidity was 85 per cent. The amount of moisture absorbed being as follows :

HYGROSCOPIC QUALITIES.

American Wood	7.00	per cent.
S. S.	4.00	"
Schultze, Pompton	3.40	"
Schultze	3.25	"
E. C.	2.50	"
DuPont's black	2.25	"
Walsrode, grain	2.25	"
Walsrode, leaf	2.00	"
DuPont's smokeless	2.00	"

The author considers velocities of between 800 and 900 feet at 40 yards the best for shot guns. Less than 700 will not kill; more than 900 give a bad pattern. Judged by this criterion all of the above powders except the two Walsrode and the DuPont black were worthless after exposure to moisture as above described.

The effect of drying was tested by exposing in a closed oven to a temperature of 205° F. for one hour, cooling and then loading with normal charge; the results are shown in the following table in which is compiled the mean pressure of these powders under normal conditions and their highest pressures, after exposure to heat, in pounds per square inch.

DRY HEAT TEST.

Powder.	Normal Mean Pressure.	Highest pressure after heating.
American wood	6,145	7,159.6
Du Pont's black	7,203	7,908.3
E. C.	7,584	9,011.1
Walsrode, grain	8,402	9,231.6
Schultze	8,894	9,408.0
S. S.	8,313	10,249.9
Schultze, Pompton	10,995	12,539.1
Du Pont's smokeless	9,510	14,700.0

The author holds that while a bursting strain of 12,000 pounds to the square inch may be considered comparatively safe, yet such a pressure is certainly too high to be endured by the average gun for any length of time. "A gas pressure of 10,000 pounds may be considered to have reached the highest point of safety for a continuous charge." Judged by this criterion the last three powders must be rejected.

It should be said that in compiling the column of "Normal Mean Pressure" great difficulty has resulted from the fact that the experimenter has varied more than one factor in a single experiment of a comparative series and we may add that he also fails to note the grades of the various powders tested.

The tests of primers with the Smokeless, Eley, Winchester Rival, Rival No. 3, Nitro Club, Kynoch, and U. S. Rapid, gave the first place to the Smokeless.

The "Composition of Certain Modern Powders," is given by Charles E. Munroe in *J. Am. Chr. Soc.* **15**, 1, 1893, the powders analyzed belonging to the so-called nitro-powders, and all being claimed to be more or less smokeless. The "volatile," (hygroscopic moisture) was determined by drying over calcium chloride to constant weight. The dried samples were then digested in ether-alcohol, somewhat diluted, filtered through a weighed asbestos filter, (prepared by filling a drawn out tube with asbestos exhausted by ether-alcohol and ether), which was immersed in a beaker with ether-alcohol, washed until solution ceased and dried to constant weight. The soluble cellulose nitrates (nitro-cotton) was determined by precipitation from the ether-alcohol filtrate with three volumes of chloroform. The ether-alcohol-chloroform filtrate was evaporated and the salts present determined. The residue insoluble in ether-alcohol was extracted with boiling water, the metallic salts present determined, dried, weighed, again exhausted with ethyl-acetate and the lost by the last exhaustion noted as "gun cotton." The nitro-glycerine was determined in a Soxhlet extractor together with traces of resins or oil. When the powder was readily attacked by water the aqueous treatment preceded the ether-alcohol treatment and the salts present were extracted together with the "humus," which latter was determined by treating the residue, from evaporation of the aqueous solution, with repeated doses of nitric acid, again evaporating to dryness and gently fusing. To determine the aurin the sample was exhausted in a Soxhlet extractor with chloroform, the tared flask weighed with the residue; the residue taken up with a few drops of chloroform, transferred to a separatory funnel, shaken with strong ammonia water and separated. The chloroform solution was thus repeatedly washed with dilute ammonia until no pink color was developed in the water, then again evaporated in the tared flask and the weight of the residue determined. The difference in the two weights is aurin.

	Schultze Gunpowder.	E. C. Gunpowder.	American Wood Powder, Grade C.	American Wood Powder, Grade E.	American Wood Powder, Ten Bore Trap.	American Wood Powder, Twelve Bore Trap.	American Wood Powder (No mark).	Brackett's Sporting Powder.	S. K. Powder.	S. R. Powder.	Rifleite Gunpowder.	Maxim Powder (flat grains).	Maxim Powder (cord).	German Smokeless Powder.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Nitro-cotton	27.71	53.57	..	..	..	..	..	..	20.39	28.18	22.48	8.14	6.84	48.83
Gun-cotton	32.66	1.86	.	..	..	..	..	..	57.73	46.97	74.16	71.19	46.60	7.45
Cellulose	1.63	3.12	..	..	..	..	..	..	..	..	..	..	..	..
Paraffine	4.20	..	..	..	..	..	..	..	..	..	..	..	..	..
Barium nitrate	27.62	34.26	...	..	..	..	..	..	18.08	19.97	..	..	..	..
Sodium nitrate	2.88	3.67	15.27	17.81	14.82	13.38	9.76	19.76	..	..	..	..	..	..
Potassium nitrate	2.17	1.48	..	..	..	..	..	..	1.24	2.35	..	..	..	..
Aurin	..	0.55	..	..	..	..	..	..	..	..	..	..	..	..
Soluble nitro-lignin	..	..	29.25	24.91	33.21	29.47	24.90	31.43	..	..	..	..	..	..
Insoluble nitro-lignin	..	..	14.06	25.62	18.69	21.85	30.07	13.70	..	..	..	..	..	..
Lignin (charred)	..	..	28.08	19.15	20.27	16.59	19.55	13.22	..	..	..	..	..	..
Humus	..	..	10.32	8.65	10.65	15.62	9.89	18.94	..	..	..	..	..	..
Aurin (alk.)	..	..	..	..	..	..	..	..	1.11	1.06	..	..	..	..
Graphite	..	..	..	..	..	..	..	..	..	..	Trace	..	..	Trace
Phenyl amidoazobenzene	..	..	..	..	..	..	..	..	..	..	2.52	..	..	..
Sodium carbonate	..	..	..	..	..	..	..	..	..	..	..	2.58	1.70	..
Nitro-glycerin	..	..	..	..	..	..	..	..	..	..	..	17.90	44.60	43.15
Volatile	1.48	1.17	3.01	3.86	2.36	3.14	5.83	2.93	1.43	1.45	0.84	0.19	0.26	0.53
Total	100.65	99.68	99.99	100.00	100.00	100.05	100.00	99.98	99.98	99.98	100.00	100.00	100.00	99.96

Eng. Pat. 19,068, Nov. 4, 1891, has been granted C. H. Curtis and G. G. Andre for the following "Improvement in the Manufacture of Gunpowder": Gun-cotton (trinitro-cellulose), generally containing about 12 per cent. of nitro-cellulose soluble in ether-alcohol, is mixed with 6-16 per cent. of dinitro-cellulose and manufactured, while wet, into pellets; or the usual process for making gun-cotton is so modified as to produce a nitrated cellulose containing 18-28 parts of the dinitro to 88 parts of the trinitro-compound, which is then made into pellets. The pellets are dried and treated with a solvent capable of dissolving only the dinitro-cellulose, which is thus made to thoroughly impregnate the trinitro-cellulose and to bind it together in hard, unfriable granules when the solvent has evaporated. This hardening process differs from those previously suggested, in that they only serve to harden the surface of the granule, and leave it friable. By varying the proportion of dinitro-cellulose within the above mentioned limits any requisite degree of explosiveness may be obtained, for the larger the proportion of dissolved cotton present, the slower the rate of combustion. By dissolving nitro-glycerin in the solvent used for the dinitro-cellulose, this explosive may be combined with the new gunpowder. Suitable proportions are 44 parts, by weight, of trinitro-cellulose and 12 parts, by weight, of dinitro-cellulose, with or without 40 parts, by weight, of nitro-glycerin.—*J. Soc. Ch. Ind.* **12**, 63; 1893.

Eng. Pat. 15,865, Aug. 22, 1893, has been granted F. G. and P. S. DuPont for "Improvements in and relating to the Manufacture of Smokeless Explosives," which consists in a method of granulating gun-cotton by mixing a solvent, such as nitro-benzene, with gun-cotton held in suspension in a fluid, such as water. On agitation, the solvent has a tendency to seize the particles of gun-cotton, forming in the water a more or less coherent mass. By adding the solvent in proper proportions a well-defined granular condition results. These grains afterward undergo a process of hardening by rotation in a barrel, and removal of water and solvent contained in the grains by heat. The violence of the explosive may be modified by varying the duration of these processes or by dissolving from 2½ to 10 per cent. of a moderating agent, such as nitrated rosin or nitrated turpentine, in the solvent before mixing

with the suspended gun-cotton. The specification is illustrated by drawings of the apparatus and in the processes.

Eng. Pat. 15,866, Aug. 22, 1893, issued under the same title to the same parties, states that increased hardness and consolidation of the above described grains may be obtained by subjecting the grains to the actions of a gentle heat, not sufficient to cause vaporization of the solvent, but to remove some of the water condensed in the grains, the grain having the property of giving up its condensed water before it parts with the solvent used in its prepation, and at a lower heat.

Eng. Pat. 15,867, Aug. 22, 1893, issued under the same title to F. G. DuPont, describes an improvement on the two preceding patents which consists in emulsifying the nitro-benzene or other solvent before adding it to the gun-cotton suspended in water. By this procedure a more uniform granulation and a more complete precipitation of the nitro-cellulose is produced than when the unemulsified solvent is used. A solution of soap or sodium carbonate in pure water may be employed for producing the emulsion with the solvent.—*J. Soc. Ch. Ind.* **12**, 1057; 1893.

M. E. Leonard's "Smokeless Powder," according to Eng. Pat. 20.066, Oct. 24, 1893, issued him for "An Improved Gunpowder", consists of nitro-glycerin, gun-cotton, lycopodium, and a neutralizer of free acid, such as urea or dinitro-benzol. The most satisfactory proportions for the U. S. 30-calibre rifle are found to be

Nitro-glycerin	150	parts by weight.
Gun-cotton..................	50	"
Lycopodium	10	"
Urea crystals................	4	"

For great guns, where a further deterring and moisture-proof effect is desired, 7 parts, by weight, of cotton-seed oil are added to the above-named ingredients.

"Improvements in Methods of Securing the Chemical Stability of Nitro-Compounds" forms the subject of Eng. Pat. 22,384, Nov. 22, 1893, granted R. S. Schipphaus, it being claimed that this results from the addition of a suitable quantity of urea after the

nitro-compounds have been freed from acid as far as possible by washing. The urea is added in the form of a solution in methyl or ethyl alcohol.

Lieut. Willoughby Walker, 5th Artillery, U. S. A., gives in the *J. U. S. Art.* 2, 374–382, 1893, under the title "A New Powder," the results of a powder prepared in the Laboratory of the U.S. Artillery School and designated 3 P. P. G. The composition of the powder is not indicated, but the statement is made that "after the final proportions of the ingredients were determined and the methods of manipulation adopted, scarcely a shot was fired the result of which could not have been foretold. In the few instances of what might possibly have been classed as abnormal results, the causes leading thereto were readily discovered, and were directly attributable to the difficulty attending the manufacture of the powder by hand."

To subject the method "of controlling the pressures to as rigid a test as possible, from the same incorporation, several lots of powder were subjected to varying degrees of the same general method of manipulation, and subsequently made up into cartridges. In every instance did the pressure respond to the treatment, ranging for the same charge of 42 grains from 25,500 to 47,800 pounds per square inch.

"As was expected, the velocities varied correspondingly, but one appeared invariably a direct function of the other, so that the operator at the rifle, upon reading the pressures, knew immediately the velocity within ten feet per second; and, conversely, the operator at the chronograph knew the pressure, within 100 pounds per square inch, as soon as he took from the tables the velocity corresponding to the reading of his instruments."

Eng. Pat. 20,880, Nov. 17, 1892, to A. H. Dumford, for "An Improvement in the Treatment of Nitrated Cellulose for the Manufacture of Explosives and other Compounds containing Dissolved Nitrated Cellulose," seeks to obviate the necessity of drying nitrated cellulose before dissolving it for the purpose of making explosive compounds, by first squeezing the wet nitrated cellulose and then treating it with a "dehydrator" capable of dissolving water, such as alcohol, or preferably a solvent of the nitrated cellulose, acetone being preferred in the case of trinitro-cellulose. A slight rise in

temperature occurs during this treatment. When much water is present the operation may have to be repeated. The residual product is pressed to remove the dehydrator and dissolved water. Trinitro-cellulose is left in a putty-like condition when a solvent, such as acetone, is used as the dehydrator. The dehydrator can be separated from the dissolved water by distillation.

F. C. Glaser, in Eng. Pat. 23,105, Dec. 15, 1892, for "Process for Manufacturing Powder suitable for Practice, Ammunition, Sporting Cartridges and similar Purposes," seeks to make any explosive suitable for service ammunition more voluminous and porous by incorporating with it 20 to 40 per cent. of a soluble or volatile body, such as potassium nitrate, benzene, or paraffin oil, which has no decomposing or dissolving effect on the explosive, then making the parts into suitable forms by known means, and then removing the solvent or volatile body by boiling the grains in water or other solvent, or by evaporation.

A remarkable "Explosion of Pyroxyline" is described by C. O. Weber in *J. Soc. Ch. Ind.* **12**, 117; Feb., 1893: The complete removal of the free acids from pyroxyline being essential to its stability and the removal of the last traces being an exceedingly tedious operation, Dr. Weber sought to accomplish this result more speedily by washing with a small quantity of ammonia until the yellow color, indicative of alkalinity, had appeared, drying between filters and finally in an oven at 70° C., but during the latter operation, after about three hours exposure, and while the temperature was still at the point fixed, the gun-cotton exploded with sufficient force to tear the copper oven to pieces.

This explosion appears remarkable from two points of view: First, that it should have occurred with the dinitro-cellulose, which is scarcely regarded as an explosive, and, second, in the low temperature at which it took place, it being much below even that at which gun-cotton (hexa nitrate) ignites, between 160° and 170° C. In fact, testing pure dinitro-cellulose, Weber found its point of ignition between 194° and 198° C.

Some years ago, Weber pointed out that if we attempt to evaporate on a water-bath a concentrated solution of ammonium nitrate to which a small amount of acetic acid has been added, when we reach a certain concentration the whole mass ignites and the reac-

tion is almost explosive in its violence. This reaction is largely employed in a practical way in the sulphuric acid industry, small quantities of ammonium sulphate being added to expel traces of nitric acid, and in both cases the hydrogen of the ammonia is burned at the expense of the oxygen of the nitric acid.

Weber finds in this reaction the explanation of the explosion, the ammonia used in washing forming an ammonium nitrate, but, not being used in sufficient quantity, a trace of free acid remained to react with the nitrate in the warm oven.

H. Kolf has been granted Eng. Pat. 22,739, Dec. 10, 1892, on "Improvements in the Manufacture of Gunpowder," which consist in first impregnating a nitrated carbo-hydrate material (which may be treated if desired with a solution of an alkaline sulphite) with a solution of an alkaline nitrate, subsequently drying it, and afterwards mixing it with nitro-sugar, nitro-treacle, or nitro-glycerin, the mass being thus heated to about 40° to 60° C., so as to obtain a partially gelatinous mass, which is reduced to a completely plastic form by simply rolling, kneading, or pressing it, after which it can be moulded into any desired shape.

Through the courtesy of Col. Majendie, R. A., we are in receipt of the 17th *Report of H. M. Inspector Explosives*, 1893, forming a volume of 169 pages, which is replete with information of interest and value to readers of these notes. Among them, we note the following explosives authorized during the year: Amberite No. 1, consisting of purified nitro-cellulose mixed with nitro-glycerine, paraffin and shellac. Amberite No. 2; nitro-cellulose mixed with barium and potassium nitrate and paraffin, vaseline or graphite. Cannonite No. 1; gun-cotton with nitrates and rosin. Cannonite No. 2; gun-cotton with rosin. Fortisine; saltpeter, sulphur and charcoal with dinitro-benzene and rosin or dextrine.

Experiments made with .303" cartridges proved that, whether loaded with black powder or cordite, when capped they were entirely free from liability to explode *en masse*, but that they were liable to so explode when uncapped.

Experiments on setting fire to 2500 lbs. of cordite stored in a brick building with slated roof, heated to 100° to 120° F. proved that, while there was rapid combustion, "there was no explosion in the ordinary sense of the word," though the whole mass was consumed

in about seven seconds and the "roof of the building had been lifted almost bodily off, and had fallen to one side and collapsed." The greater part of the débris was comprised in a radius of 12 yards.

The report of Dr. Dupré shows that all of the 35 samples of dynamite No. 1 tested passed; of the 5 samples of blasting gelatine, 3 were rejected; of the 35 samples of gelatine dynamite No. 1, 4 were rejected; and of the 57 samples of gelatine dynamite No. 2., 6 were rejected.

The annual record of accidents and outrages, both English and foreign, which is an admirable feature of these excellent reports, occupies 42 pages and includes not only those in which explosives (properly called) were involved, but also many of those resulting from petroleum. In addition, in Appendix W, twenty-four pages are devoted to a detailed tabular view of the 149 accidents by fire or explosion occuring in 1892.

The carelessness shown in thawing dynamite has led to the preparation of Appendix X, giving a detailed tabular view of the seventy accidents occurring from this cause in the United Kingdom since 1871–72.

Circulars regarding the electric lighting of factories; the precautions to be adopted in the manufacture of nitro-benzole, etc.; the packing of colored fires; the precautions to be taken by users of frictional signal lights; and directions to inventors of explosives who seek entry in Great Britain, are a few among the many important subjects treated of.

Special Rept., CVII., of *H. M. Insp. Exp.*, Dec. 30, 1893, on an "Explosion at F. Joyce & Co.'s Ammunition Factory," is also received. This explosion occurred in the mixing of mercury fulminates with ground glass, potassium chlorate, and antimony sulphide, to form a cap composition, the mixing being done by shaking the powdered ingredients gently together on a sheet of paper, and then passing through a sieve in the usual way. The exact origin of the explosion is not determined, but the process is considered by Col. Majendie to be in itself a sufficient cause, and the process meets with his condemnation. He recommends that the "jelly-bag" system of mixing used at Woolwich be adopted.

Through the courtesy of Gen. H. L. Abbot, U. S. A., we are in

receipt of the three "Reports of the Board of Ordnance and Fortification," Nos. 1 and 2, being issued respectively as Ex. Doc. No. 12, 1st Session, and Ex. Doc. No. 11, 2d Session, of the House of Representatives of the 52d Congress, while the 3d appears as a publication of the War Department. Included in these are the reports of the experiments on high explosives for use in shell charges and of smokeless powders.

In the first report it is recorded that Perunite, composed of nitroglycerine, nitro-ethyl, nitro-methyl and pyroxyline, takes rank as the most powerful explosive tested, the force of the following according to the sub-terra trials being:

Perunite B	17.57
" C	15.61
" D	13.66
Explosive gelatine	10.00
Rackarock	9.36
Emmensite	5.49
Gun-cotton	3.16
U. S. rifle powder	1.72

A scheme for testing explosives for safety, permanency, strength and sensitiveness is given, the novel feature being the proposed rotating machine for determinating the danger of premature explosion from the rotation of shells induced by the rifling.

In the second report, Americanite is rejected as a shell charge.

In the third report Americanite is condemned, and Rackarock in the normal proportions is found to be unsafe. Justin's system of loading explosive gelatine is found meritorious, as far as it has been carried, and it has been demonstrated that wet gun-cotton and emmensite may be safely used as service charges in the 12-inch mortar shell. The most important need now is a proper detonating fuse.

In "The Determination of the Relative Sensitiveness of Explosive Substances Through Explosions by Influence," *J. Am. Ch. Soc.*, 15, 10; 1893, Charles E. Munroe says: "The determination of the sensitiveness of explosive substances has already been made by a number of different methods, but it is yet a question as to the real value of these results. Thus, we have the methods by percussion,

by heat, by friction, and the like. It has occurred to the author that a much more delicate and reliable method would result from the application of what has been termed by Berthelot 'explosion by influence.' What is meant by this term is the explosion of a secondary mass through the explosion of a primary mass which is separated from the secondary mass by a definite interval. Numerous observations have been made, as notably in the Danish experiments, on explosions of this kind taking place under water, and a great many instances are recorded of similar explosions being brought about on the surface of the earth; but the submarine experiments were made with a limited number of substances confined in envelopes which materially modified the results, while the earth experiments were made under continually varying conditions. In his experiments he employed a continuous and, as nearly as may be, homogenous medium, through which the effect of the explosion of the primary mass was conveyed to the secondary mass, while he used definite and moderate quantities of explosives under constant conditions of confinement—circumstances which are easily repeated, while the attending phenomena are easily observed.

The method pursued was as follows:

The initial and secondary masses were placed upon a wrought iron armor plate nine feet five inches long, three feet four inches wide, and one inch thick, which rested upon a second plate of the same material and dimensions. As these plates had been made for use on vessels of war, they contained several lines of rivet holes and were curved to the shape of the vessel. This, of course, affected the rigidity of the system, and it was expected that it might introduce irregularities into the results, but firing trials made under otherwise similar conditions showed that for the masses of explosives used the results were uniform at all points.

The initial mass consisted of 100 grams of explosive, while the secondary mass varied from 30 to 100 grams, it being evident that the weight of the secondary mass had no effect on its initial sensitiveness, and that it was essential only to have a sufficient quantity to produce a positive and visible effect on the firing plate in case it was exploded.

In the experiments for testing the relative sensitiveness of different explosives when referred to a common standard, 100 grams of

United States service gun-cotton was selected for the initial mass because it was the most accessible, convenient and constant one at hand, but apart from these considerations there is an advantage in using this as the initial mass, since it has been shown by Abel that gun-cotton is the most efficient detonating priming agent among explosive substances.

The gun-cotton, as issued from the Naval Torpedo Station where it is manufactured, is in the form of blocks two and nine-tenths inches in diameter, three and seven-eighth inches in diagonal (the corners being chamfered), and two inches in height, and it is made by compressing pulped gun-cotton in molds by means of a hydraulic press, the pressure applied being about 6500 pounds per square inch. The blocks are pierced through the center with a hole seven-sixteenth inch in diameter in which the detonator is to be inserted for firing. This gun cotton was steam-dried before using, and pieces of 100 grams weight were cut off by cutting transversely to the vertical axis, so that the diameter of the base of these pieces was that of the blocks from which they were taken.

As all the other explosives were in the form of either a powder or paste, it was necessary to provide containers for them, and these were made from well calendered manilla paper. When these explosives were used for the initial mass, the boxes had the same form and dimensions as the service block of gun-cotton, except that the corners were not chamfered, and hence the area of the surface in contact with the plate was very closely the same as for the gun cotton. When these explosives were used as secondary masses they were enclosed in similar open paper boxes, but they were but 5.58 centimeters in diameter. In all cases, the explosive was evenly distributed over the bottom of the case and brought well in contact with it, so that the area of the face of these different explosives in contact with the firing plate was as nearly as possible identical. It is evident from this description that the explosives were tested when unconfined except from atmospheric tamping.

In making the test it was of course necessary to proceed in a purely tentative manner. A point was selected upon the plate where no breaches of continuity were apparent for a considerable range, the initial mass was placed upon the plate and at the outset of each series two secondary masses (one being placed on

either side of the initial or primary mass and at unequal distances from it) and the primary one detonated. When this was detonated it produced a well marked impression on the iron, and the same effect was observed in the case of the secondary masses when they were detonated, the effect, however, being in all cases diminished as the secondary mass approaches that point at which it ceased to be detonated. The observations were most easily made when gun-cotton was used for both the primary and secondary charges, for when the secondary charge was not far beyond the limit at which secondary charges could be detonated, it burst into flame and was tossed into the air in this inflamed condition through the disturbance produced in the atmosphere by the detonation of the initial mass.

When non-detonating or sub-detonating explosives were used for the secondary charges, impressions were produced so long as explosion was effected, but the impressions produced, at least near the extreme limit, were due only to the removal of scale from the plate by the shock of the explosion and to the deposition of soot and other products. When beyond this limit the explosive was found scattered upon the plate together with fragments of the containers.

As the limit was approached, single secondary charges only were used with each initial charge in order to simplify the observations. The points measured were from the inside edge of the primary mass to the inside edge of the secondary mass before explosion.

The results obtained were as follows, with 100 grams of guncotton as the initial charge the following were the maximum limits at which detonation took place:

Gun-cotton	10	c. m.
Explosive gelatine, (camphorated)	20	"
Judson R. R. P.	25	"
Emmensite, (No. 259)	30	"
Rackarock	32	"
Bellite	50	"
Forcite, No. 1	61	"
Kieselguhr dynamite, No. 1	64	"
Atlas, No. 1	74	"

These were rather unexpected results as they were at variance with the prevailing idea that the nitro-substitution powders were less sensitive to sympathetic explosion than any others. When the same explosive was used for both the initial and the secondary charges, the following results were obtained:

EMMENSITE ON EMMENSITE.

Initial mass.	Secondary mass.	Distance.	Result.
100 gms.	30 gms.	10 c. m.	Exploded.
100 "	30 "	11 to 30 c. m.	Failed.

ATLAS ON ATLAS.

Initial mass.	Secondary mass.	Distance.	Result.
100 gms.	30 gms.	11 to 30 c. m.	Exploded.

FORCITE ON FORCITE.

Initial mass.	Secondary mass.	Distance.	Result.
100 gms.	30 gms.	11 to 15 c. m.	Detonated.

KIESELGUHR DYNAMITE ON KIESELGUHR DYNAMITE.

Initial mass.	Secondary mass.	Distance.	Result.
100 gms.	30 gms.	11 to 30 c. m.	Detonated.

Circumstances prevented the further carrying out of these experiments, but it is to be hoped that some explosive expert with a large theoretical as well as a practical experience will take them up, as they undoubtedly will lead to results of practical interest.

Lieutenant C. de W. Willcox has cleverly translated for the *J. U. S. Artil.*, **2**, 408, 1893, a very valuable paper, by Colonel Ritter U. von Wuich, appearing in the *Mitt. Art. Genie-Wesens.*, No. 2, 1891, on the "Combustion Temperature of Explosives."

Although accepted but provisionally, and regarded with skepticism, the calorific intensities recorded in our literature, and upon which subsequent calculations are based, are for black gunpowder 3000°–4000° C., gun-cotton 5000°–6000° C., nitro-glycerin 7000°–8000° C. The most obvious objection offered to the adoption of these figures is that even the lowest of them is above the melting point of gun metals.

Discussing the data of Noble and Abel, Bunsen and Schischkoff, E. Wiedemann and others, von Wuich finds, at the outset, that a cardinal error in these estimations or determinations consists in

assuming that the specific heats of the products of combustion are independent of the temperatures of the products, and using, in consequence of this view, constants which had been determined at the freezing point, whereas von Wuich finds it evident, from simple logic based on the phenomena of nature, that thermal capacity decreases as the quantity of heat in a given body increases.

He then proceeds to estimate the specific heats of the products at the higher temperatures, and applying his results he finds that, whereas, when calorific intensities, or, as he styles them, combustion temperatures, are obtained with specific heats determined at 0° C., he gets 3340° C. for gunpowder, 4893° C. for trinitro-cellulose, and 7240° C. for nitro-glycerin; using his newly-developed expression for the specific heat, he obtains 1874°, 2516° and 3005° C. for gunpowder, gun-cotton and nitro-glycerin, respectively.

The following conclusions have been reached by H. B. Dixon in his investigation of the "Rate of Explosion in Gases" (*Eng. and Min. J.*, 55, 129, 1883):

1. Berthelot's measurements of the rates of explosion of a number of gaseous mixtures have been confirmed. The rate of the explosion wave for each mixture is constant. It is independent of the diameter of the tube above a certain limit.

2. The rate is not absolutely independent of the initial temperature and pressure of the gases. With rise of temperature the rate falls; with rise of pressure the rate increases; but above a certain crucial point variations in pressure appear to have no effect.

3. In the explosion of carbonic oxide and oxygen in a long tube, the presence of steam has a marked effect on the rate. From measurements of the rate of explosion with different quantities of steam, the conclusion is drawn that at the high temperature of the explosion wave, as well as in ordinary combustion, the oxidation of the carbonic oxide is effected by the interaction of the steam.

4. Inert gases are found to retard the explosion wave according to their volume and density. Within wide limits an excess of one of the combustible gases has the same retarding effect as an inert gas (of the same volume and density), which can take no part in the reaction.

5. Measurements of the rate of explosion can be employed for determining the course of some chemical changes.

In the explosion of a volatile carbon compound with oxygen, the gaseous carbon appears to burn first to carbonic oxide, and afterward, if oxygen is present in excess, the carbonic oxide first formed burns to carbonic acid.

6. The theory proposed by Berthelot—that in the explosion wave the flame travels at the mean velocity of the products of combustion—although in agreement with the rates observed in a certain number of cases, does not account for the velocities found in other gaseous mixtures.

7. It seems probable that in the explosion wave: (1) the gases are heated at constant volume, and not at constant pressure; (2) each layer of gas is raised in temperature before being burnt; (3) the wave is propagated not only by the movements of the burnt molecules, but also by the heated but yet unburnt molecules; (4) when the permanent volume of the gases is changed in the chemical reaction, an alteration of temperature is thereby caused which affects the velocity of the wave.

8. In a gas of the mean density and temperature calculated on these assumptions, a sound wave would travel at a velocity which nearly agrees with the observed rate of explosion in those cases where the products of combustion are perfect gases.

9. With mixtures in which steam is formed, the rate of explosion falls below the calculated rate of the sound wave. But when such mixtures are largely diluted with an inert gas, the calculated and found velocities coincide. It seems reasonable to suppose that, at the higher temperatures, the lowering of the rate of explosion is brought about by the dissociation of the steam, or by an increase in its specific heat, or by both these causes.

10. The propagation of the explosion wave in gases must be accompanied by a very high pressure lasting for a very short time. The experiments of MM. Mallard and Le Chatelier, as well as the author's, show the presence of these fugitive pressures. It is possible that data for calculating the pressure produced may be derived from a knowledge of the densities of the unburnt gases and of their rates of explosion.

A. Mitscherlich has studied the "Ignition Point of Gaseous Mix-

tures" (*Ber.* **26**, 399, 1893), and for a mixture of hydrogen and oxygen, in the proportion of 2 : 1, by volumes, he found the point of ignition to vary with the pressure and with the shape of the containing vessel. Under the same conditions, and for pressures less than 760 mm., the temperature of ignition fell in direct proportion to the decrease of the pressure of the gaseous mixtures.

For pressures higher than 760 mm. the only conclusion that could be drawn with any degree of certainty from the experiments was that the point of ignition of gases is higher when they are compressed than when they are not, which is contrary to hitherto accepted views.

Free hydroxylamine, NH_2OH, has been isolated by M. Lobry de Bruyn (*Recueil des Traveux Chimiques des Pays-Bas*, **10**, 101, 1891), the free base being obtained as follows : About a hundred grams of hydroxylamine hydrochloride, $NH_2OH.HCl$, were dissolved in 600 cc. of warm methyl alcohol. A quantity of sodium dissolved in methyl alcohol was then added, in such proportion that the hydrochloride was present in slight excess over and above that required to convert it to sodium chloride. After deposition of the separated sodium chloride the solution was decanted and filtered. The greater portion of the methyl alcohol was next removed by distillation under the reduced pressure of 160–200 mm. The remainder was then treated with anhydrous ether, in order to completely precipitate the last traces of dissolved sodium chloride. The liquid eventually separated into two layers, an upper ethereal layer, containing about 5 per cent. of hydroxylamine, and a lower layer containing over 50 per cent. of hydroxylamine, the remainder of the methyl alcohol, and a little dissolved salt. By subjecting this lower layer to fractional distillation under 60 mm. pressure, it was separated into three fractions, of which the first contained 27 per cent. of hydroxylamine, the second 60 per cent., and the third crystallized in the ice cooled receiver in long needles. This third fraction consisted of free solid NH_2OH. Hydroxylamine, as thus isolated in the free state, is a very hygroscopic substance, which rapidly liquefies when exposed to air, owing to the absorption of water. The crystals melt at 33°, and the fused substance appears to possess the capability of readily dissolving metallic salts. Sodium chloride is very largely soluble in the liquid; powdered

nitre melts at once in contact with it, and the two liquids then mix. Free hydroxylamine is without odor. It is heavier than water. When rapidly heated upon platinum foil it suddenly decomposes in a most violent manner, with production of a large sheet of bright, yellow flame. It is only very slightly soluble in liquid carbon compounds, such as chloroform, benzene, ether, acetic acid, and carbon bi-sulphide. The vapor attacks corks, so that the solid requires to be preserved in glass stoppered bottles. The free base appears also to act upon cellulose, for, upon placing a few drops of the melted substance upon filter paper, a considerable amount of heat is evolved. The pure crystals are very stable, the base in the free state appearing to possess much greater stability than when dissolved in water. The instability of the solution appears, however, to be influenced to a considerable extent by the alkalinity of the glass of the containing vessel, for concentrated solutions free from dissolved alkali are found to be perfectly stable. Bromine and iodine react in a remarkable manner with free hydroxylamine. Crystals of iodine dissolve instantly in contact with it, with evolution of a gas and considerable rise of temperature. Bromine reacts with violence, a gas being evolved explosively and hydrobromic acid formed. The nature of the gas evolved is now undergoing investigation. M. Lobry de Bruyn warns those who may attempt to prepare free hydroxlamine by the above method that it is a dangerously explosive substance when warmed to a temperature of 80°–100°. Upon warming a flask containing the free solid base upon a water-bath a most violent explosion occurs. A spontaneous decomposition appears to set in at about 80°, and even in open vessels the explosion is very violent. Care must also be taken during the fractional distillation of the concentrated solution in methyl alcohol to cool the apparatus before changing the receiver, since, if air is admitted while the retort is heated, the experiment ends with an explosion.

Among recent works are to be noted "Traité Théorique et Pratique des Matières Explosives,"* by Léon Gody, which is a most satisfactory book for general readers. It contains, in a permanent form, the lectures given by the author at l'École d'Application and at l'École de Guerre. Naturally, as the author treats to some

*8vo, 480 pp. Ad. Wesmael Charlier, Namur, France, 1893.

extent of most of the explosive substances known, from black powder, pyrotechnics and liquid fires through the nitric ethers and nitro substitution products, to the endothermic organic and inorganic compounds that are rarely to be found outside the limits of the research laboratory, it follows that his treatment is not exhaustive. Unfortunately, the book, which is otherwise arranged and printed in a convenient and attractive form, is without an index.

In these Notes,* we have called attention at some length to the appearance of the third edition of Berthelot's "Sur la Force de la Poudre," and to the originality and importance of the book. Time has but emphasized its great value to students of explosives, hence, in order to render it accessible to a larger number of readers, C. Napier Hake and William McNab have, at the suggestion of Col. Cundill, R. A., translated it into English, condensing much, omitting the repetitions consequent on the form in which it originally appeared, and issuing it in a single volume in place of the two volumes of the original, under the title "Explosives and their Power."† The translators have not only translated the French of Berthelot, but they have rendered a greater service in translating the older chemical notation, which Berthelot persists in using, into the modern notation which is more generally understood, and they have added abstracts of Berthelot's later essays on the propagation of detonation in explosive gaseous mixtures and his studies on the "explosive wave" in solid and liquid bodies. The work of the translators is admirably done and the book is issued in very good form indeed.

"Explosifs de Surête Grisoutite—Wetter dynamites—Explosifs a Base d'Azotate d'Ammoniaque,"‡ by A. Macquet, consists of two memoirs by the author, which are bound up with various documents from other sources. The matter is badly digested and arranged, and is evidently intended as an endorsement of grisoutite. There is a good deal of information regarding the dangers attending the use of explosives in fiery and dusty mines; the results of the experiments of the French and Austrian commissions

*Proc. Nav. Inst., 11, 275, 1885.
†8vo, 563 pp., 43 ill., John Murray, London, 1892.
‡8vo, 594 pp., Baudry & Co., Paris, 1893.

being given with the other documents; and the relative advantages of various explosives proposed for use in such mines, is discussed, but it is difficult to get at the information on any particular topic, especially as the book lacks an index.

A. Pouteuax has added another book to the rapidly-increasing literature of smokeless powder, entitled "La Poudre Sans Fumée et les Poudres Anciennes,"* and though a book of some size, practically but little over thirty pages are devoted to modern smokeless powders, the rest of the space being given to black powder and its substitutes in the chlorate and picrate classes; to methods of measuring pressures and velocities; and to devices such as the pneumatic guns of various kinds; all of which is more fully and exactly treated of in other works. The book has an index but it is a rather curious one.

Through the courtesy of Capt. Jas. M. Ingalls, 1st Artillery, U. S. A., we are in receipt of a copy of his "Interior Ballistics,"† a text-book prepared for the use of student officers at the U. S. Artillery School. As must be the case with text-books, the greater part of the matter is collected from other sources, which are properly cited by the author, but the chapters which deal with the behavior of the powder in the gun, the effect on the velocity of combustion of variations in the form and size of the grains; the derivation of formulas for estimating the pressures and velocities consequent on the known characteristics of the powder, and allied topics, contain much original matter. The author modestly states that, with the exception of the original matter in these chapters, "he has simply culled, from various sources, what seemed to him desirable in an elementary text-book, arranged it all systematically, from the same point of view, and with a uniform notation," but he has succeeded in making a book which is well digested and arranged and in which the matter is presented in a clear and concise manner.

*8vo, 156 pp., Ed. Dubois, Paris, 1893.

†8vo, 158 pp., 2d ed., Artillery School Press, Fort Monroe, Va., 1894.

Through the courtesy of Lieutenant J. H. Glennon, U. S. N., now on duty at the U. S. Naval Academy, we are in receipt of a copy of his "Interior Ballistics, with a Short Treatment of the More Common High Explosives."* The methods followed in the treatment of the subject are an elaboration of those employed by the author in his article on "Velocities and Pressures in Guns,"† Sarrau's General Equation, which holds for but a particular case, being dropped, and simpler methods of calculation being used. Among other features, we note that the relations between breech and projectile pressures are given, problems on the recoil of the gun while the projectile is in the bore and on the initial velocity of recoil are solved, and attention is called to the fact that a pressure-gauge in the base of the shell does not, as ordinarily constructed, show the accelerating pressure. The methods used in finding the laws of the combustion of gunpowder are unusual, while the law for the combustion of an explosive, under variable pressure, is deduced by a novel method, suggested by the study of the velocity of escape of a gas through a vent. In the chapter on smokeless powders, the methods of solution of problems for these new ballistic agents are indicated, though complete data for the discussion of a variety of cases were unobtainable. It is pointed out that nearly all the early data on the firing of guns lacked precision in important particulars, and in this work we are supplied with formulæ through which, when the DeBange gas-check is used, the exact volume of the powder-chamber may be readily calculated.

*8vo, 153 pp. Deutsch Litho'g and Printing Co., Baltimore, 1894. Address U. S. Naval Institute, Annapolis, Md.

†PROCEEDINGS NAVAL INSTITUTE 14, 395-418; 1888.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

CLEANING THE BOTTOMS OF STEEL SHIPS BY DIVERS, WHEN DOCKING IS IMPRACTICABLE.

By Lieutenant-Commander U. Sebree, U. S. N.

During the year 1891, the U. S. S. Baltimore was not docked for eleven months. For eight months of that time she was in the waters of Chili and Peru. While in Chili, the bottom of the ship was cleaned by divers belonging to the crew of the ship. The whole of the bottom was cleaned once. The forward third of the bottom was gone over a second time. The propellers were cleaned three or more times.

The Charleston, San Francisco, Boston, and probably others of our new vessels have used divers for cleaning the bottoms. The Chilians have for years used divers for cleaning the bottoms of their vessels. I have been unable to find anything published on the subject, and think that an account of the method used on the Baltimore may be of interest; and hope that other officers who have had experience on this subject, or who may have given any thought to it, will give their views on it.

The Baltimore was docked at Toulon, France, in February, 1891; and the bottom was painted with McGinnis' paint. Immediately afterwards she sailed for Chili, and arrived at Valparaiso about the 1st of April. She remained in Chili and Peru until the middle of December, when she sailed for San Francisco, and was docked at the Mare Island Navy Yard in January, 1892.

Within four or five months after arriving in Chili, the ship began to lose her speed on account of foul bottom; and it was decided to clean the bottom with divers. There were on board, in the

crew, two seamen gunners who had qualified as divers at the Torpedo School at Newport, besides Mr. Peter Hanley, the gunner, who had also taken the diving course at Newport; and who had general charge of the diving gang while the work was being done. The sailing launch was used for the pump. In a safe and smooth harbor, a scow, or camel, would be better. But at Valparaiso we had to use the launch. Several of the thwarts were unshipped, and the pump was lashed to the bottom boards of the boat. An iron ladder was secured on the side of the launch, next to the ship, for the use of the diver in getting into the water, or into the boat when he stopped work. One of the iron ladders, taken from one of the ventilators on deck, was used. It was about ten feet long, two feet wide, and was curved at the top so that it hooked over the gunwale of the launch, well aft. It was fitted with iron braces that fitted up against the side of the launch, under the counter, and was held rigidly in a perpendicular position. For use under the ship, a wide Jacob's ladder was made on board. The sides were of 3-in. manilla and were about 20 fathoms long; or long enough to reach from the spar-deck under the ship, and up to the deck on the other side. There were 10 rungs, placed 18 inches apart, and every other rung was weighted with old grate bars, lashed to it. The rungs were of pine boards, 10 feet long, 4 inches wide, and 2 inches thick. While cleaning the bottom the diver was always on this ladder, or between it and the ship's bottom; and he would stand, sit, or lie down on the ladder, as was most convenient for his work. The pump and diver's dress were those supplied to the ship in her outfit.

The scrapers used were of wood (either oak or ash), and were made in the shape of a wide chisel. They were about 4 inches wide and 8 inches long, the handle end being rounded down. A number of them were made by the carpenter, and they were kept sharpened, or trimmed down, like the edge of a chisel. They were pushed before the hand, like a chisel, rather than being pulled like a scraper.

The diver chose the man who attended the life line. This important duty should be done by a practical diver. On the Baltimore, it was done by the other diver. Four men were in the launch besides the man who attended the life line. Two of these worked the pump, and the other two attended the bow and stern

lines of the launch, and would relieve the men at the pump every half hour. Four men were required on deck, to attend the lines, lower and haul up the ladder, and shift it when necessary.

The general routine for the diving work was as follows: The sailing launch's crew would lower the launch, and haul her alongside, where needed. Four men from the working division for the day would go in the launch, and four other men from working division, generally under charge of one of the gunner's mates, would be on deck, to get the Jacob's ladder in position, and attend the lines, while the work was going on. The diver, and the man who attended the life line, would go in the launch, and the diver would put on the diving suit, except the helmet. The iron ladder would be hung over the launch's side and secured. The launch dropped or hauled to right position, and secured by bow and stern lines. The Jacob's ladder would be hauled so that the upper rung was just awash. The diver would stand on the iron ladder, the helmet be put on, the lines, hose, etc., adjusted and the pump started. The diver would go down, get inside the Jacob's ladder, and start the work with his wooden chisel. He would clean a fleet ten feet wide, and when ready, would signal to lower the ladder. When the fleet was finished to the keel, he would signal, slack off (say) port and haul up starboard. The ladder would be pulled up by the men on the deck, with the diver on it. When his helmet appeared the ladder would be shifted aft, with the diver on it, and he would start in on another fleet. He always worked from the water line, *down*. When the time came to stop the work for the day, the diver came up, got on the iron ladder, and was helped into the launch, and took off his diving suit. The boat was dropped under davits and hooked on and hoisted, and, in this particular case, was generally rigged in and secured in her cradle, the pump being left in her. The lines on deck were hauled taut, and left under the ship for the night.

The signals used were established to suit the work, and were:

3 pulls on life line,	Pull me up.
2 " " "	Lower me.
1 pull " "	All right.
2 pulls on hose,	Less air.
1 pull " "	More air.

1 pull on life line, followed by 2 pulls,								Lower forward starboard.
3 pulls	"	"	"	"	2	"	"	" port.
2 "	"	"	"	"	2	"	"	aft starboard.
4 "	"	"	"	"	2	"	"	" port.
1 pull	"	"	"	"	3	"	"	pull up forward starboard.
3 pulls	"	"	"	"	3	"	"	" " port.
2 "	"	"	"	"	3	"	"	" aft starboard.
4 "	"	"	"	"	3	"	"	" " port.

The two divers worked on alternate days, and they were limited to five hours a day; as it was thought that, in the cold waters of Chili, more than five hours a day would be bad for their health.

The divers were allowed $1 per hour in addition to their regular pay. They were allowed 15 minutes in each hour for a breathing spell. But after a little experience, they did not take this spell, and would often remain down at work two, and even three hours without coming up. If they took the 15 minutes in each hour, the time was not deducted; but if they did not take it, they were *not* credited with that much more time. The time taken to clean the bottom once, and to clean one-third of it a second time was a little over two months. The actual number of hours of diving work, as taken from the Paymaster's vouchers, was 200 hours 14 minutes. This time includes all the diving done during three months. The propellers were cleaned several times; the Kingston and other valves cleaned, and a third of the bottom was gone over a second time. So that it would be fair to say that the bottom was cleaned the first time with 150 hours of diving work. This work was done under adverse circumstances, in the exposed harbor of Valparaiso. Often a sea would make, and the work would have to be stopped within an hour after it was begun.

The launch was hoisted every night, and the ship kept ready for getting under way at short notice. As the men became accustomed to the work, they became very expert at it, and did much more work at the last.

The barnacles on the bottom of the Baltimore the first time she was cleaned, averaged about 2¾ inches in length. Some of them were 3 inches long. They were often in clusters, so that they extended six inches or more from the ship's bottom. These large barnacles were difficult to get off, and they generally took off three coats of paint with them; the McGinnis green, the brown, and a coat of red lead. A great many of them were examined, and I am

of the opinion that they did not take the inner coat of paint, and the cement paint with them: so that at that size I do not think taking them off exposed the metal. When going over the bottom the second time, the barnacles were of about six weeks' or two months' growth, and were about $\frac{1}{4}$ to $\frac{1}{2}$ inch long. These brought off with them only one coat of paint, the green.

After the bottom was cleaned, the gunner made an inspection, and reported that it was well done. When the ship was docked at Mare Island, it was seen that the work had been faithfully done. The line up and down the ship's bottom, showing where the last fleet had been cleaned the second time was as clearly defined as if the cleaning had been done in dry dock. On one side of this line, the bottom was practically clean. On the other side were barnacles of about three months' growth, about $\frac{1}{2}$ to $\frac{3}{4}$ inch long.

The vessel suffered no serious loss of speed through having a foul bottom.

From the experience on the Baltimore, I think that two divers, working, each on alternate days, can, after a little practice, in warm water, and where the barnacles have not more than three months' growth, clean the bottom of a 5000-ton ship in from 120 to 140 diving hours, or at six diving hours a day, in from 20 to 24 days. And if it were necessary, each diver could work five hours a day, or ten hours total per day; and they could clean the bottom in two weeks.

And if a ship is so placed that she cannot be docked, the cleaning should be begun at the end of three months, when the barnacles are small, and come off easily, and do not bring off much paint with them; and the cleaning should be repeated every three months. This can be done with her own men, at a cost of $600 or less per year, and the ship can be kept so that she will suffer no serious loss of speed on account of her bottom.

In addition to this, the divers, diving suits, pumps, etc., will be ready for use and kept in order, so that if the diver should be needed to make repairs, etc., he will be in practice, and the apparatus ready.

The objection that may be urged to cleaning the bottom is, that the barnacles take off the paint, and thus expose the metal to the water, and that pitting may take place. When the Baltimore was docked at Mare Island, I was not able to detect any pitting from that cause.

My opinion is that a vessel can be kept practically clean, and suffer no serious loss of speed, and not be injured by pitting, for at least a year, by the use of her divers, at a cost of $600 for labor, about $70 for two new diving suits, and the original cost in outfit of about $600 for the pump. The pump should, with care, last indefinitely, 15 or 20 years.

DISCUSSION.

Rear-Admiral DANIEL AMMEN, U. S. N.—The explanation of the process of cleaning the bottom of the Baltimore is very clear. The so-called harbor of Valparaiso is only a roadstead with deep water for anchorage, subject to heavy swells and high winds liable to greatly embarrass such work.

Some years ago, a friend brought to my notice an invention of Mr. Freeborn, designed to cleanse ships' bottoms by means of petroleum. I brought him in communication with the Navy Department, and understood that he was offered an opportunity of trying it on a tug at Boston, but am without further information on the subject.

It seems to me that it might prove of advantage to endeavor to prevent the fouling of ships' bottoms; and this could readily be done with the means used in cleaning the bottom of the Baltimore. After a voyage, I suggest thinning coal tar by means of adding as large a quantity of crude coal oil or naphtha, as may be found necessary, and adding to the mixture, mechanically, a certain amount of London purple. A large funnel with a stop-cock could be hoisted or lowered on board the vessel to secure the desired rate of outflow of the liquid through a hose and a suitable "rose," as on a watering pot, to spread the fluid. The diver could begin forward on the line of the keel, and the current would tend to sweep the liquid aft, while the specific gravity would cause it to rise towards the surface, and as the coal tar is very sticky, even under water, a thin coating might be formed, after some practice in distribution, over the entire bottom of a material that would perhaps kill animal and vegetable growth, and delay further formation for a time.

A trial would not be troublesome or expensive, and the effects would be readily ascertained. It is supposed that dead barnacles and grass fall off. If that should not occur, the diluted coal tar might delay for a time a further growth, and thus render less frequent the necessity of cleaning the bottom by the process of scraping.

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The following is a portion of Mr. Freeborn's reply to a request for further information on the subject; it was received after the above discussion was written:

ADMIRAL AMMEN, *Ammendale, Md.*

Dear Sir:—In answer to your inquiry I would state that on account of ill-health I have made no experiments since 1891, three years this summer.

The last applications I made in 1891 were only partially successful, in consequence of the vessels lying in port for some time before applying the oil, the foul water from the sewers in the docks having killed the barnacles. The cement attaching them having set, the oil had no effect on the dead ones.

The following conditions are necessary to insure success, namely:

1. The barnacles must be alive, and the application made before a second crop attach themselves in sufficient numbers to kill those already adhering to the vessel's bottom.

2. An application should be made every three months.

3. The application must be made at sea and before entering harbor.

4. The vessel should be put to her full speed immediately after the application.

I have not been able to make a trial under the conditions stated, but have full faith that success would be the result.

I send you copy of the English patent, as I find that I have no copies of the American patent with drawings attached; also, find copy of letters from Brazil Mail Steamship Co. In the mentioned cases the vessels were covered with grass, slime, and a barnacle different from the ordinary one.

I intended to start in May to renew trials of the invention, my health being sufficiently restored to superintend the application of the oil during the summer months.

A good plan would be to meet a man-of war on some West India, Central American, or even South American station after three months cruising. After applying the oil, the speed of the vessel, under the same pressure of steam before and after, would indicate the success or non-success of the invention.

I will be pleased to give you any further information which I may have, or answer any questions, should you so desire.

Most respectfully, WM. FREEBORN.

Lieutenant-Commander B. F. TILLEY, U. S. N.:—I appreciate the practical manner in which Mr. Sebree has presented this subject. It is a matter of great importance. The ability to clean a ship's bottom with her own divers means that it is possible to restore to her at any time her approximate full speed without docking, and without outside aid. It can easily be imagined that, in the operations of actual war, this power would be invaluable. With our unsheathed ships, even a slight fouling of the bottom causes great decrease in speed, and in tropical waters the fouling progresses very rapidly and the loss is enormous. Even under the ordi-

nary conditions of cruising, in times of peace, cleaning the ship's bottom might enable her to make a passage otherwise impossible, and, in an extreme case, might thus save the ship. It often happens that our new ships are not docked for a full year. The Philadelphia, now at Honolulu, has not been docked since June, 1893. The Boston remained out of dock for about the same length of time, and with several other new ships the exigencies of the service on which they were engaged have prevented them from being docked for eight or ten months. If it were not possible to clean the bottoms of ships with divers, I do not think that, after being so long in tropical waters, a twenty-knot ship would make over sixteen or seventeen knots, and there would be difficulty in maintaining even that speed. The experience on board the San Francisco, while I was attached to her, confirms what is stated by the writer to have been practicable on board the Baltimore. After a little practice, we found that the ship's divers were able to clean the ship's bottom in about the same time and at about the same cost as is given for the Baltimore in this article. The procedure on board the San Francisco was similar to that on board the Baltimore, but instead of using an iron ladder taken from the deck, an iron ladder was made especially for the purpose. This ladder was fitted to hook over the stern of the sailing launch, and to project a little from the boat. While the divers were at work a red DANGER flag was always displayed from the boat where the pump was worked, to prevent tugs, etc., from running near. On many occasions, when it was not desirable to clean the ship's bottom, the propellers and sea-openings for valves were cleaned by the divers. When the divers were working on the propellers it was found most important to inform the chief engineer and the engineer on watch, so that the engines could not by any chance be turned. A neglect of this precaution might easily cause the diver to lose his life. It should be a part of the "routine." The diver being always in a perilous position, it appears to me that the system of signals used on board the Baltimore was too complicated. I think that there should be but a few simple signals, and that the safety signal, "pull me up," should be one pull on the life-line, so that the diver, even if panic-stricken or injured, would make it almost involuntarily.

As to the compensation for divers, I think that the extra fifteen minutes in each hour for breathing spell should always be allowed in computing the amount due them, even if they do not come up to breathe. This liberal treatment would encourage them, and, at the most generous estimate of their work, they receive far less compensation than divers in civil life receive for the same service. This applies especially to the occasions when they work for only a few hours, as in cleaning the propellers, where, with the breathing time allowance, the amount received for the risk and labor would not be more than four or five dollars. When a ship is fitting out, I would suggest that the executive officer exercise great care in regard

to the diving apparatus supplied. Both the pumps and diving suits should be tested before leaving a navy yard, and no inferior article should be accepted. It is economy for the Government to have all the articles of the very best quality. I make this suggestion because, on going to sea in the San Francisco, I found that the ship had been supplied with old diving suits which had been repaired. They began to leak as soon as we used them and the divers were wet and uncomfortable while at work.

While I regard it as so important that a ship should be able, with her own resources, to clean her bottom, the risk of taking off the paint with the barnacles, and thus exposing the bottom to rust, is too great to warrant doing it unless it is very necessary to increase her speed. It should not be done habitually to save coal in ordinary cruising.

Lieutenant-Commander W. T. SWINBURNE, U. S. N.:—I am glad to add the testimony of my experience in the Boston to Mr. Sebree's on so important a subject as the preservation of the cruising qualities of a modern ship on stations where docking facilities are few. This has been shown to be particularly the case on the Pacific Station, and the experiences of those on the Baltimore, and other ships on that station, would seem to show that, with a little care, the speed of a ship can be kept intact for an indefinite time, with but little danger to the bottom.

During the time I was attached to the Boston, in the harbor of Honolulu, from August, 1892, to May, 1893, the ship's bottom was cleaned by the ship's divers twice. The methods we employed were almost identical with those described by Mr. Sebree. The two trysail ladders from the main mast, lashed end to end, were used under the bottom, oars were lashed across them, about four feet apart, to give a wider support for the diver, the lower point was weighted with grate bars, and the whole raised or lowered by tackles from the awning ridge rope on either side of the ship The diver, partly lying and partly sitting on the ladder between it and the ship's bottom, using a coir clamp brush, with a handle about six feet long, was able to clean a streak about ten feet wide, from waterline to keel at each fleet. We had two divers, one working in the forenoon and one in the afternoon. As they gained experience, the work required no supervision from the officer-of-the-deck, and interfered with none of the ship's routine.

For details, I must refer to Lieutenant Laird, who was senior member of the Quarterly Board of Inspection during the time referred to, and who was present when the ship was docked, on her return to San Francisco, and who can quote accurately from the very admirable records he kept of his various inspections.

Lieutenant CHARLES LAIRD, U. S. N.:—Mr. Sebree, in his paper, has called attention to a subject of the greatest importance.

It has been shown in the last three years in the cases of the Baltimore, Boston, Charleston and San Francisco, that, with the limited docking

facilities on the west coast of America, some method should be pursued for the care and preservation of the under-water body of ships, which, through stress of circumstances, are compelled to remain out of dock for an extended period of time.

That the ship's bottom can be kept comparatively free from animal and vegetable growth, by the work of ships' divers, has been definitely settled.

I desire to call your attention to the case of the Boston, during her last cruise. The condition of the under-water body was reported upon by the permanent board at the time of docking at Mare Island, in May, 1892, and again at the same place, in October, 1893, an interval of one year and five months. During the greater portion of this time the ship was moored in the harbor of Honolulu, and the conditions were such as to be favorable to a rapid growth of submarine matter on her under-water body.

Quoting from the journal kept by the permanent board, and from the quarterly reports made by that board:

"The ship was docked in the Navy Yard, New York, October 1, 1891; the starboard side was painted with McGinnis and the port side with germicide paint."

When the ship was again docked at Mare Island, May 26, 1892: "It was surprising that the under-water body should be so free from vegetable growth. During the cruise in southern waters, this growth accumulated with great rapidity about the waterline, and, as far as could be seen on the under-water surface, it adhered with the greatest tenacity, and was with difficulty removed, when it was possible to list the ship for scraping and repainting the exposed surface. That this vegetable growth had disappeared, may be due to the fact of the ship having been alongside of the dock at the Navy Yard, from the 4th to the 26th of May, in water more or less fresh, and that, together with the great amount of sediment in the Napa River, may have tended towards its removal.

"The most marked evidences of deterioration were found in the bottom blow-pipes, the rivet heads being so much eaten away by the salt water as to necessitate removal. On the keel plates were found evidences of pitting, but none of a serious nature; more pits were found at and about the waterline than at any other portion.

"The paint applied to the bottom whilst in dock was as follows:

First coat, ⅔ red lead, ⅓ zinc.
Second coat, ⅓ red lead, ⅔ zinc.
Third coat, pure American zinc.
Fourth coat, pure American zinc.

An interval of two days between each coat was allowed, in order that the paint should dry thoroughly."

From May, 1892, to October, 1893, when the ship was next docked, the bottom was cleaned three times by two men of the ship's company, working as submarine divers.

This work was done in the harbor of Honolulu; the same general plan was followed as that described by Mr. Sebree.

The ship's bottom was first cleaned by the divers during the quarter ending December, 1892.

The divers reported the condition of the ship's bottom as follows: "A rough surface of grass about 1½ inches long, about the bilge, and grass 6 inches long, hanging to the bottom." For the removal of this growth the divers used the ordinary bristle clamp brushes, fixed to handles about 6 feet in length.

Two specimens of the growth were taken at different points, for the purpose of getting an approximate idea as to the accumulated weight on the ship's bottom. The grass taken from one square foot of surface on the port side weighed eleven ounces, and that taken from an equal area on the starboard side weighed ten and one-half ounces.

In June, 1893, whilst the ship was at anchor in the harbor of Lahaina, Maui, an inspection of the under-water body was made with the aid of a water-telescope. The general opinion of the board was that the paint was adhering well, and that there was no marked evidence of deterioration.

In the clear water of this harbor an excellent view of the ship's bottom was obtained. It was conclusively shown that the work of the divers had been well done.

During the month of April, 1893, the ship's bottom was again cleaned, the same method being pursued.

There was a marked change in the character of the growth on the ship's bottom. The vegetable growth had disappeared, and in its place was found an animal growth, covering the entire under-water surface from 2 feet below the water-line to the keel. The growth adhering to the ship's bottom was firm and tough, resembling cartilage; one specimen brought up by the divers was 15 inches in length, 6 inches in width, 2½ inches in depth, and weighed 3¾ pounds; the scale of oxide of iron adhering to the under surface was 5-32 inches thick.

The divers worked during this month 113 hours.

In August, the ship again visited Lahaina, for target practice. An inspection was made at that time with the aid of the water-telescope, and the divers' work found to be well done. Places on the keel, reported as being in bad condition, could be plainly seen.

The ship's bottom was again cleaned by the divers in September, 1893, the total time for work being 71½ hours. In cleaning the bottom at this time, iron chisel scrapers, fixed to handles about six feet in length, were used. The character of the growth had again changed. The divers reported the bottom as being covered with a growth of needle coral, the needles being from 1 to 6 inches in length.

Upon the return to the coast, the ship was docked at Mare Island, October 20, 1893.

Quoting from the report of the quarterly board: "In general, the paint was found to have adhered well, but was worn and abraded in places. Little or no vegetable, and but little coralline growth was found, except in the unavoidable holidays left by the divers.

"On the hull there were but few evidences of pitting; clusters from 1½ inches to 6 inches in diameter were found, but in no case were the pits of greater depth than 1-16 of an inch.

"On the propeller there were two clusters of small deep pits, near the edge of diametrically opposite blades, on the reverse side, near the entering edges. The other blades were free from pits.

"Numerous rust spots of inappreciable depth, isolated and in patches, were found; the patches varied from ½ to 6 inches in diameter." Beneath the paint, no matter how well preserved and adherent, a jet black oxide of iron was found.

That the ship was kept in a more efficient state as to speed and economy in the use of fuel by these repeated cleanings, there can be no doubt, nor was this done at the expense of the ship's bottom. Should this submarine matter have had an uninterrupted growth during the months the ship was in southern waters, the result would, in all probability, have been much more serious.

The water-telescope aided so materially in the inspection of the ship's bottom, in the clear water off Lahaina, that I add a description of its construction, together with the use made of it in an attempt to take a photograph of the after-run and propeller.

A rectangular box, 1 foot by 1 foot by 3 feet, was constructed, the joints of which were water-tight. One foot from the lower end a plate of clear glass was set within the box, rabbeted to the wood, so as to make the joint water-tight. As close as possible to the under-surface of the glass, holes ¼ inch in diameter were bored through the box, to permit the air-bubble to be excluded. Handles were fitted on opposite sides, one foot from the upper end; the lower end was weighted with sheet-lead, to reduce the buoyancy, and the inside painted white, to reduce the absorption of light.

It was found that, in comparatively smooth water, the telescope could be readily handled in the dingy; and, that a very clear idea could be gained as to the manner in which the divers had performed their work.

An attempt was made to photograph the propeller and after run of the ship.

Assistant-Surgeon Thomas C. Craig, a photographer of some experience, made the attempt, the failure of which was due to lack of time, and the sea becoming so rough as to endanger the camera.

In attempting to take the photograph, the following plan was adopted: Battens were nailed on the inside of the telescope, on which the camera rested, with the lens one inch clear of the glass of the telescope. The admission of the light to the lens, from the back of the camera, was entirely cut off.

The camera fixed in the telescope, was focussed on an object sixteen feet distant, that being about the distance of the keel from the water-line; the whole was then taken in a boat, the lower end of the telescope submerged, and directed towards the after-run. The picture, as seen on the focussing glass, was clear, sharp, and distinct. At this time, however, the sea became so rough that the experiment had to be abandoned.

Commander G. A. CONVERSE, U. S. N. (Inspector of Ordnance, Torpedo Station, Newport).:—(1). The regular course in diving, at the Naval Torpedo Station, embraces three weeks of practical work, during which the men are taught, (*a*) how to handle the air-pump; (*b*) to dress a diver; (*c*) to communicate and receive signals to and from him; (*d*) diving in shoal water; (*e*) diving in deep water. In addition to this course of instruction, they have, during the time they are here, a great deal of practical work to perform: for example, during the last summer they put down an extension, one hundred feet long, to the ways for the Cushing, doing all the work of scarfing the ways, aligning, putting on the iron straps, etc., under water, and so well was the work performed that not a single hitch occurred the first time the cradle was run down, and the Cushing put in place at the lowest of neap tides. More recently, they have worked for three successive days, in upwards of fifty feet of water, with the temperature of the air nearly down to freezing, and successfully raised a submarine boat, displacing approximately 10,000 pounds. They also, last month, did work on the bottom of the training-ship Portsmouth.

(2). The telephone has not been used to any extent, either here or abroad, so far as I am aware. Many devices have been made, and some of the experiments are reported as successful; I believe those made in Germany. I have had consultations with some of the prominent wreckers in regard to the matter, and they all seemed opposed to its use. One objection seems to be that, in almost any form in which it has yet been proposed to use it, it simply adds one more line and one more chance for the diver to become entangled. Another is that the present means of signalling seems to answer all requirements; and still another objection, in my opinion the true one, is an evident disinclination on the part of those who are under water, and on the spot where work is to done, to be bothered or to be obliged to receive definite instructions from those who are attending them from the deck of the vessel, who can, from the nature of their position, know little or nothing of the details of the work which they cannot see. In this opinion, I must agree that the diver, to be a successful workman, must be "boss" of the situation, and the duty of those who are attending him must be simply to supply him with air, according to his directions, carry out the instructions which he has previously given them, and to guard against any accident happening, whereby his safety may be imperiled.

(3). The usual signals employed are as follows:

LIFE-LINE.

Pulls.	By Diver.	By Tender.
One	Am "all right."	Are you "all right"?
Two	Ease me down.	I will ease you down.
Three	Pull me up.	Come up; or, I will pull you up.

AIR-PIPE.

Pulls.	By Diver.	By Tender.
One	More air.	Answer by one pull on life-line (I will comply).
Two	Less air.	Answer by two pulls on life-line (I will comply).

Two pulls on the life-line and two on the air-pipe, in rapid succession, indicates that the diver is foul and cannot free himself. On receiving this signal no attempt should be made to haul him up, but his signal should be answered and another diver sent down to release him.

(4). Regarding the cost of a diving suit:—A complete diving apparatus, including pump, helmet, hose, weights, etc., etc., and two pairs of diving dresses, costs about $600. After the outfit is once purchased it is really necessary to procure no supplies other than dresses, which cost about $35 each, snap-tubing, etc. Our apparatus at this Station has been in use from 15 to 20 years, and the pumps are still in good condition. As a rule, we obtain two diving dresses a year, this being necessary on account of the extreme wear and tear caused by the frequent dressing and undressing made necessary by the course of instruction.

(5). We have not yet published anything in regard to instructions to divers, but one of the officers has the preparation of a handbook on diving under way, and it is my intention to have it completed and published during this Spring. Some of the principal features which I desire to embody are illustrations of pumps and the various articles of outfit.

(6). As a rule, we get all of our apparatus from Alfred Hale & Co., of Boston, Mass., having started out with them and finding it desirable to always obtain articles which will fit the apparatus which we have on hand. Andrew Morse & Son, also of Boston, make good apparatus, as do also two or three firms in New York, one especially, by the name of Schroeder, if I mistake not, who supplies largely to the Merritt Wrecking Co. We have also a complete suit of English apparatus made by Siebe & Gorman, the pump being intended to be used with two divers if necessary. Our experience with this has been, however, that unless both divers are working at the same level, the one nearest the surface is apt to get the greater part of the air at the expense of the poor fellow who happens to be under him. Still, it works.

I am glad to learn of the success in keeping the bottom of the Baltimore clean, and also that the Boston was able to do the same. Capt. Sampson told me last summer that he cleaned the bottom of the San Francisco with the divers and believed there was no difficulty whatever in keeping vessels of that class in good steaming condition with their own crews and a comparatively inexpensive diving outfit.

It is particularly pleasing to me to know that the instruction which has been given to these men at this Station is at last bearing fruit. A change of sentiment seems to have come over the men, as well as over the service at large. Now those who are here qualifying for seamen-gunners, without exception, unless absolutely forbidden by the Surgeon, qualify as divers, and seem to like the work. It is the usual thing when a detail of men is wanted for deep water diving, to have more volunteers than are required for the work, and this too, when at this Station they are not allowed extra compensation for any work however important and even supplementary to the course of instruction.

In the operation of raising the submarine boat a few days ago, our instructor in diving was ill, and the officer who has regular charge of that branch of instruction was absent on detached duty. The entire operation was successfully performed by the men, of course under the general supervision of an officer.

Some of the wrecking vessels are fitted with air-pumps worked by steam, and I saw one in use not very long ago, similar in appearance to the small donkey pumps used on board ship, which could not have weighed more than 250 pounds.

I think that the day is not far distant when all of our vessels will be fitted with a pump of similar description, located at some convenient place amidships, so that the length of hose required for those engaged in cleaning the bottom need not exceed, at the utmost, 200 feet.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

ON GUNSHOT INJURIES PRODUCED BY THE NEW PROJECTILE OF SMALL CALIBER.*

By Henry G. Beyer, M. D., Ph. D., Surgeon, U. S. Navy.

In looking over the literature of the experiments made by military surgeons with the new rifle and projectile of reduced caliber, it occurred to me that a short account of the results, so far obtained, might not only prove interesting to you, but would also tend to make you all the better appreciate the necessity for the instruction in the principles of "First Aid to the Injured," which you are shortly to receive, besides having a direct bearing on your profession.

It is a fact well known to you that the nature and character of any injury to the human body must depend to a large extent upon the nature and character of the agent that produces it—be this accidentally or intentionally.

The more common and well-known instruments by means of which the great majority of wounds and other injuries are produced in the ordinary walks of life, are generally so well known and so simple, that an experimental study of their effects on the human body may well be neglected. Besides, the conditions under which injuries in every-day life occur are so manifold, that it would indeed be a difficult task to devise plans of experimentation in order to systematically study them all before they occurred.

It is, however, very different with cases of injury that are produced by firearms. Here we have at once certain uniform conditions that may very advantageously be studied beforehand, and a

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great deal of practical experience and knowledge can be gained by experiments on dead human bodies, as well as on living animals, in regard to the nature of the injuries produced by them.

Different fire-arms produce different injuries and, consequently, any change in the one must likewise be followed by changes in the other, and, since the treatment of all injuries again depends upon the nature of the injury itself, it also must be modified to suit the new conditions of things, whatever they may be.

The most important change in the new small firearm that has been made and that interests us in this connection, undoubtedly, consists in the reduction of the caliber of the gun. The improvement, in other words, has gone on in the same direction in which it started some fifty years ago, namely, in the doing away with the round ball and the smooth-bore barrel and the substitution of a pointed projectile within a rifled barrel.

Thus the old Minié arm had a caliber of 18 mm.; then came the Prussian needle-gun with a caliber of 14 mm., which proved its superiority in the war of 1866 against Austria; next came the chassepot and Mauser guns with a caliber of 11 mm., and now the present small-arm with a caliber of from 7.5 to 8 mm. And no sooner had the caliber of the 7.5 mm. been more generally adopted, than the Italian and Roumanian armies were fitted out with rifles of the caliber of 6.5 mm., and this tendency towards reduction has by no means come to an end yet and may reach 5 mm. before very long.

The great superiority of the French chassepot over the Prussian needle-gun was never more plainly shown than at the battle of Gravelotte, in which alone 19,863 Prussian soldiers were wounded, owing to the murderous effect of the chassepot.

Along with the reduction of the caliber of the projectile a reduction in weight has come about from 50 to 15 grams, and a still greater reduction is expected.

The result of a reduction in caliber means, as you may know, increased velocity for the projectile, increased distance and a surer aim. In this manner a small-arm has been produced that will impart a velocity of from 4–600 meters per second to the projectile and send it a distance of from 4–5000 meters; the rotatory velocity has been calculated to be from 800–2500 rotations per second. Habart calculates the velocity of the Männlicher projectile, model

1888, to be 620 meters per second, and the number of its rotations at 2480, which would mean four rotations to the meter, or one rotation to 0.25 meter.

It is principally due to Professor Hebler, a German artillery scientist, who published a pamphlet in 1882; the results of his studies demonstrate most conclusively the advantages to be gained by a reduction in caliber and the use of hard mantles for the projectiles.

The importance of this publication is most evident when we realize that the change therein recommended was at once adopted and is now an accomplished fact with all modern armies. It may perhaps be interesting, in this connection, to note how nearly Hebler was anticipated in his discovery by the English army-surgeon Longmore (quoted by La Garde), who, in 1870, expressed himself as follows: "If bullets of steel or any similar hard and coherent metal should ever be found capable of being economically employed in firearms, many of the ordinary features in gunshot wounds, as they at present exist, will be materially changed. In proportion as the hardness and cohesive force of the metals increase, the greater also will be the ease with which the brass plates and other accoutrements, the strong bones of the extremities, the vault of the cranium and any resisting structures will be perforated by it. Again, we shall have bullets which will not become softened at ordinary increases of temperature, broken and dispersed in fragments, subject to loss of substance, and capable of undergoing the various alterations in form which leaden bullets are apt to assume on coming in collision with certain external objects and hard parts of the body."

Indeed, the general adoption of this new small-arm is in no small measure due to the results obtained by experiments made on dead human bodies and living animals by military surgeons.

Thus we find military surgeons busy experimenting with this new instrument of destruction as early as 1886.

In Germany it was Busch and Reger who were among the first to call attention to the difference in the destructive effects produced between the old leaden bullets of large caliber and the new hard bullet of small caliber. From Russia the subject received valuable experimental contributions through Professors Morowsow, Tauber and Pawlow. In France, Delorme, Chavasse, Chauvel and Nimier did excellent work in their experiments with the Lebel rifle

on dead human bodies. Bruns, of Germany, and Habart, in Austria, came out with the results of experiments made with the Mauser and Männlicher guns respectively. Quite recently Smith, of England, published some very painstaking experiments with the Lee-Metford bullet on the bones of horses, and the United States are most creditably represented in this matter by a most valuable experimental contribution made by Captain L. A. La Garde, of the Army, which is published in the last report of the Surgeon-General to the Secretary of War.

Inasmuch as the effect of projectiles upon the human body must be more or less complicated, owing to the composition of that body, it is the usual thing to begin the study of any new projectile by first ascertaining its effect on simpler materials, such as wood, iron and water, the resistance of which is tolerably uniform.

Thus, one of the first results obtained with the new rifle on wood was that its penetrative effect was from 5 to 6 times greater than that of the old arm.

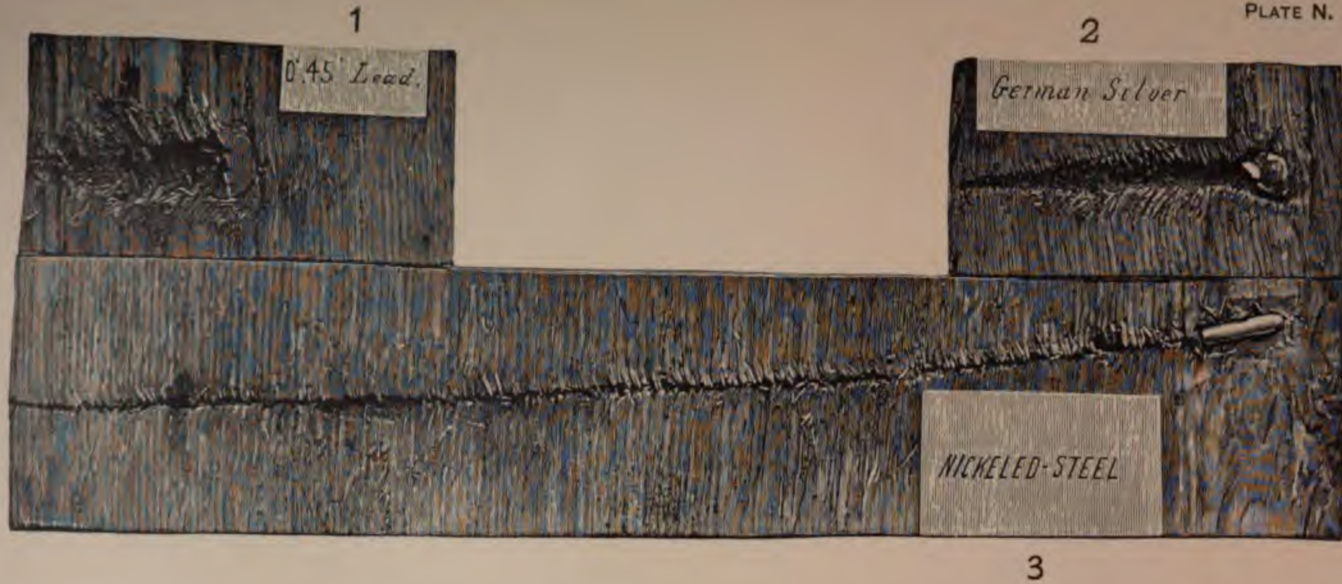
La Garde found the maximum penetration in solid blocks of oak, not thoroughly seasoned, fired across the grain, at 3 feet from the muzzle, with a striking velocity of 2000 foot seconds, to be as follows:

230-grain	copper-covered	bullet	penetrated	4	inches.
220 "	G. S.	"	"	5.3	"
220 "	cupro-nickeled steel	"	"	19.5	"

If it is assumed that a projectile capable of penetrating a wood-board of one inch in thickness would still suffice to put a man out of combat, then this new arm is capable of doing double that amount of work at 1800 meters distance, and when, furthermore, it was likewise ascertained that the new projectile penetrates an iron plate 12 mm. in thickness near to, and one 2 mm. in thickness at a distance of 1000 meters, it becomes pretty evident that the steel-helmet and cuirass have at once become a useless burden and rather antiquated.

In some German experiments, made with the new bullet under water, in which the pressure was ascertained by a manometer, it was found that this pressure was much greater than had been anticipated, amounting to as much as 15 atmospheres. The resistance offered by water is very great, and a projectile that will cover

PLATE N.



Shows the penetration in hard oak, against the grain, 3 feet from the muzzle, of the following projectiles:

1. .″45 caliber leaden projectile, 500 grains; I. V., 1300 f. s. .... 3.2″
2. .″30 caliber German silver jacketed projectile, weight, 220 grains; I. V., 2000 f. s. .... 5.3″
3. .″30 caliber nickel-steel jacketed projectile, weight, 220 grains; I. V., 2000 f. s. .... 19.5″

The latter was not deformed.

PLATE I.

a distance of 4000 meters in the air, will advance but two or three meters under water. But this increased pressure is, in part at least, overcome by the shape given to the new projectile, and while the form of the old leaden bullet was much changed, that of the new bullet remains unaltered.

The chemical composition of the mantle of the new projectile, as shown in the above-mentioned experiments of La Garde, seems to be the at present more important consideration in its penetrative effect, the softer compositions causing deformation, their penetrative effects are greatly lessened, thus changing the entire character of the arm.

The copper- and German silver-covered projectiles were very much deformed in the experiments of La Garde, whilst the cupro-nickeled steel-covered projectile retained its shape unaltered, and since the velocity of the projectiles and the hardness of the oak blocks were constants in the experiments, the difference in penetration can only be due to the deformation of the bullets. These results would make it pretty certain that the cupro-nickeled jacket has more resistance than any of the others, and its penetrative effect must, consequently, be greatest.

Of the European armies which are supplied with this cupro-nickeled-bronze bullet, there are the German, Belgian and the Turkish. The Russian and French armies are supplied with projectiles of hard lead covered with Melchior-metal, and the Austrian army is supplied with projectiles covered by nickel-steel.

Thus, it will be easy to understand how many are the peculiarities which the new arm presents when studied in detail, and how manifold must be their influence on the injuries which they produce, even when regarded from the point of view of their penetrative effects alone.

But the new arm possesses also an increased explosive effect, which likewise deserves attention because its influence on the human body, and the nature and character of the injuries inflicted thereby, must be very marked. What do we mean by explosive effect? We have already mentioned that the pressure caused by the new arm under water was equal to about 15 atmospheres, and to this hydraulic pressure must be attributed to a large extent the explosive effect which the new arm produces.—(*Hebler*).

Some of the experiments of La Garde may perhaps better than anything else illustrate the probable nature of this effect.

LaGarde employed (1) empty powder cans, firing into them at various distances; he found that in the empty cans the orifices of entrance and of exit were proportional to the size of the projectile employed. (2) He next used powder cans used with wet saw-dust; in these the orifice of entrance presented no special features, while the orifice of exit was marked by a bursting forth of the tin, and a loss of the contents of the box. The cans, he says, had expanded as if driven apart by some internal force which had been exerted in all directions. (3) He then took powder-cans filled with water; in this case the results obtained were similar to those with wet saw-dust, only much more extensive, and about equal for the two projectiles which were employed.

The term "explosive effect," then, undoubtedly, as used in connection with injuries, owes its origin to the fact that the conditions which are found are similar to those produced by an explosive bullet.

In his further studies of the explosive effects produced by the Springfield and the experimental Springfield rifles respectively, La Garde found that no difference existed in the injuries which they both produced up to a distance of 200 yards, but that, at this distance, the old rifle ceased to produce explosive effects while the new Springfield rifle continued to do so up to a distance of 350 yards.

I will, for the sake of giving a general sketch of a wound showing explosive effects, quote from La Garde's report, who says:—"When we say that a wound shows explosive effects we mean that it appears as though it has been caused by an explosive bullet. There are no special features, as a rule, to describe about the wound of entrance (powder-can) except the appearance at times of bony sand in the tract leading to a fractured bone. When a resistant bone has been hit, the foyer of fracture will show great loss of substance, the bone will have been very finely comminuted, the pulverized bone will have been driven, not only in the direction in which the projectile was traveling, but in all directions, and the pulpification of the soft part will not only be limited to the track of the bullet, but the utter destruction is noticed to extend some distance into the surrounding tissues. The wound of exit appears like a bursting forth of the skin: the track leading to the bone is conical in shape, the base of the cone corresponding to the wound of exit in the skin, and the apex to the seat of fracture."

In short, then, the term "explosive effect" is applied whenever the injury produced by a certain projectile is found to be entirely out of proportion to the size of the bullet itself, that is, when the wound caused by it is much more extensive than would be necessary to have it admit the simple and easy passage of it, and whenever the surrounding tissues are either pulverized or pulped for a distance around the track of the bullet.

Now, although it is true that the amount of explosive effect produced depends upon the velocity of the projectile on the one hand, and the resistance offered by the tissues struck, it has been produced not only in bones, but also in the soft tissues such as muscles and the internal viscera as the heart, liver, spleen, kidneys, stomach, intestine and bladder. In other words, the amount of resistance offered to the projectile by the different tissues of the body has, as experiments would seem clearly to demonstrate, not as much influence on the results as we would be inclined, at first thought, to attribute to it, and the velocity of the projectile appears to have the lion's share in the production of the explosive effects. Habart also has shown that the hydraulic pressure theory is not tenable, neither is the theory of Melsen, who thought that a column of air was traveling in front of the projectile and which reached the body before the projectile did, and that to this was to be attributed the apparent explosive effect. In the case of the projectile entering the stomach, intestine or bladder, the amount of injury done to these organs seems to depend greatly on whether they are empty or whether they contain their normal ingesta. The damage done is much greater when they are full. In apparent contradiction of this, Habart exhibited a human heart, the result of a suicide, that had been perforated at 10 paces with a Männlicher projectile but which showed no explosive effect but merely a simple perforation; as he, however, suggests himself, the ball must have entered the heart in a moment of systolic contraction, when, as you know, it is practically a solid piece of muscle without fluid contents.

Let us now, after these considerations, look at this new arm in its relation to the injuries which it produces on the human body, and let us examine some of the results of the experiments that have so far been made in this direction.

One of the first and principal points that had to be ascertained

in the case of every gunshot wound before the introduction of the new arm, was, as to whether the margins of the wound were contused and lacerated or not. In the former case we naturally expected that the healing process would be long and tedious; in the latter case this would not be the case, but the margins might be brought together by sutures and immediate healing take place.

Now, the new projectile differs from the old in that the lead which forms the body of it and gives it the necessary weight, is completely surrounded by a hard mantle, particularly so about its point. The former leaden bullet meeting with resistance, was at once considerably changed in shape, the small amount of heat produced in the collision melting it and, consequently, the resulting surface of contact became, comparatively speaking, large.

This is no longer the case with the new bullet, and while, perhaps, under certain circumstances, a slight dulling at the point takes place, this will hardly ever amount to enough to cause a material enlargement in the points of contact.

It has, it is true, been found, when the new projectile struck very hard substances, such as quartz, that the steel mantle became loosened and was stripped off, giving rise to an altered shape of the bullet, but even then this alteration did not assume the grotesque shape that the old bullet often did and is of rare occurrence.

Experience in the field had over and over shown that the amount of contusion and laceration were always greater, the greater the amount of contact surface of the injuring object, and experiments had demonstrated that the contused margins came not only from too great pressure upon the surface of the skin, killing every particle of it instantly, but that it was also due to overstretching which more especially resulted in extensive lacerations.

This essential character of gunshot wounds has been greatly changed through the introduction of the new gun. The experiments so far made give the resulting wounds as smaller and with much less contused margins than those produced by the old bullets. The theoretical supposition, that, owing to the small caliber and its increased velocity we would be led to expect small wounds with sharply cut edges, was borne out by practical experimentation. The amount of substance that is removed by the new bullet resembles in shape a cylindrical piece, although perhaps ground into atoms and not retaining the shape of the opening which its removal by the bullet leaves in the injured part.

In wounds confined to the soft parts alone, no very great difference in extent of injury between the wound of exit and that of entrance will generally exist; at most, we may find a more serious condition about the wound of exit or the point at which the ball leaves the injured member. Healing then, in wounds of the soft part alone, will, in the majority of cases at least, proceed a good deal after the manner in which this process is accomplished in wounds made by the knife, providing that antiseptic precautions are used.

There is, however, a new side in the character of the wounds thus produced which requires our consideration, and although the cleanness of the cut produced by the new bullet has, as we have seen, its advantages, so far as healing is concerned, it also has certain dangers not to be lost sight of.

The greater, for instance, the amount of contusion and laceration in the wounded part, the less may we also expect the hemorrhage to be, for nothing favors the arrest of hemorrhage so much, temporarily at least, as does the stretching and lacerating of arteries.

The new projectile, cutting like a knife, or, worse still, after the manner of a scoop, produces neither contusion nor laceration and, consequently, nothing to arrest the hemorrhage occasioned by the injury, in case an artery of some size has been cut. The direct consequence of this will be a much greater number of deaths from hemorrhage in the field than has been the case in previous wars.

Besides, formerly, instances occurred quite frequently in which large arteries lying right in the very track of a bullet had not been injured, the bluntness of the contact surface having pressed them aside and thus the bullet had avoided them. No such results are expected to occur in the future. The new bullet will, in its rapid flight, scoop out a piece of the wall of an artery and leave it gaping. This has already been proven, not only by experiment but by actual experience in the field. In the late civil war in Chile, in which a certain number of the congressional troops were armed with the Männlicher rifle, the number of deaths from this cause, according to Stitt and Videro, was calculated to have been about four times as great as that with the old bullet. This fact has been furthermore confirmed in numerous attempts at repressing street-riots, and also during the civil war in the Argentine Republic, where

the mortality from this cause is said to have reached the highest rate. Kipper relates the following interesting case: A recruit, having his rifle at "order arms" accidently fired off the charge; the ball entered his neck cutting out a piece of the external carotid artery as if by a scoop and, consequently, death from hemorrhage was almost instantaneous.

The nerves seem to be the only structures, according to some experimenters, that escape injury sometimes by being apparently pushed aside.

Shots through the lungs with the new projectile seem rather more favorable than with the old bullet, in spite of the track being from three to four times larger in diameter than that of the bullet. Vessels may show clean perforations at great distances. Thus it has been found that, at 2000 meters distance, a shot received in the neck cut the internal jugular, wounded the sympathetic nerve and caused a fracture of the spinous and articular processes of one of the cervical vertebræ.

A projectile fired off at a distance of 600 meters and entering the chest perforated the margin of the sternum, traversed the lung, went through the body of the fourth dorsal vertebra and carried away its transverse and spinous processes, besides also fracturing the lamina of the fifth vertebra.

When a shot enters the abdomen, the intestinal canal is generally found perforated in several places. The openings have the diameter of the bullet when the canal was empty at the time, but more extensive lacerations are the consequence of the injury in case the canal is distended by its normal contents.

The openings made in the fasciæ covering the larger muscles are usually found to be smaller in diameter than those made through the skin, while the serous membranes, as the pleura or the peritoneum, show wider breeches of continuity.

The most characteristic injuries and the most extensively studied are undoubtedly those done to the bones.

Formerly, most any bone of any thickness seemed sufficient to arrest the old bullet; it was often found, very much deformed, imbedded in the substance of an irregular bone, having produced extensive and wide-spread splintering, thereby causing a rather complicated condition of the wound and greatly impairing the normal process of healing of the soft parts.

PHOTO. A.

PHOTO. B.

Instances have occurred even with the old projectile in which it had gone clean through the knee-joint without wounding either bone, something which is not impossible at any rate when the leg is in semi-flexion and the ball enters from behind. But such instances as these are, of course, still more likely to occur in the future with the new projectile, which perforates several of the strongest bones in succession, rarely, if ever, remaining imbedded. Trees of great thickness and brick walls are no longer a protection against bullets. The increased velocity of the modern projectile will no longer allow of the easy and formerly often experienced deviation in the course of the bullet, as experiments on human cadavers have abundantly demonstrated.

But the greatest difference is here noticed with regard to the distance from the muzzle at which the projectile strikes the bone and also as to whether it strikes the harder portions, such as are found in the shafts of long bones, or the softer and more spongy portions of the bones, that are found in the articular extremities. It is owing to this difference of effect from different distances that the range of fire within which bones may be struck in an actual campaign has been divided into different zones. Although we still find slight differences of opinion to exist between the different experimenters with regard to the extent of these zones and the character of the injuries produced within each, yet the fact that each zone presents its characteristic injuries to bones cannot be doubted for an instant. The causes for this difference of opinion seem to lie, on the one hand, in the difference in the projectiles used by the various experimenters leading to varying results, and, on the other, in the different conceptions that they have of what is termed "explosive effect."

It seems a mistake that, because of an artificial division of the range of fire being made, the injuries must always be necessarily of the character described for the majority of them; exceptions must occur, and occur frequently.

Habart, who is undoubtedly one of the most clear-headed experimenters in this direction, and whose authority therefore deserves the greatest possible consideration, distinguishes four zones, viz: 1. The zone of explosive effect which lies within 500 metres; 2. The zone of *mean* distance which is between 500 and 1200 metres; 3. The zone of *long* distance between 1200 and 2000

metres, and 4. The artillery-zone lying anywhere beyond 2000 metres.

As a general rule, we would be led to expect to find injuries showing explosive effects within the limits of the first zone in accordance with the results obtained by most of the experimenters, fractures of bones with loss of substance and most extensive splintering. Within the second and third zones purely perforative effects would be the rule, the extent of the fissures and the number and size of the splinters varying with the distance. While beyond 2000 metres, or within the limits of the artillery-zone, we again find more serious injuries to the bones recurring.

But Habart himself mentions a case in which he obtained a purely penetrative effect within a hundred paces, and also other instances in which explosive effects were found produced at distances of 1500 to 2000 metres. And Delorme states that injuries to the diaphyses of long bones are always remarkable for their extent and gravity. Whether they are struck at a distance of 500 metres or 1500 metres, the damage done to a long bone by one of the new projectiles seems about the same; in both cases there are always fissures produced that are from 10–12 cm. long, the only difference being that at longer distances the splinters are more often found still adherent to the periosteum.

Capt. Smith, of England, one of the latest experimenters, states that within the 200-yard range no appreciable difference was noted between the damage done to dense and rarified portions of bone. Smith made his experiments on horses, ponies, donkeys and sheep, at first on these animals in their entirety, and afterwards on excised bones which were hung on a canvass target and fired at from varying distances up to 1000 yards. His experiments, if we were to judge by his photographic illustrations, would carry the explosive zone much further than usual, and the Lee-Metford rifle with which he experimented can certainly not be called a humane weapon.

Thus, Fig. 1 in Photo. *A* shows a bone fired at from a distance of 50 yards; the bullet struck it about the centre of its shaft, and a chasm 2 inches by 4 inches resulted, which was filled with bone-dust; the bone was broken into two pieces, and in the track were hundreds of fragments, clearly showing the shell-like effect. Fig. 2 of Photo. *A* shows practically the same effect.

PHOTO. C.

PHOTO. D.

Photo. *B*, Fig. 1, shows an arm bone which was hit at a distance of 800 yards; it was demolished with considerable loss of substance; the fracture extended down into the elbow-joint, through two or three distinct lines, and long fissures also ran up the shaft of the bone.

Even in the three figures in Photo. *C*, we still see extensive fissuring with loss of substance; and in the four figures shown in Photo. *D*, taken from specimens obtained from the 1000-yard range, we see anything but a pure and simple penetrative effect.

Smith says that when the thigh-bone of any one of his animals was struck at a distance of 50 yards in the middle of the shaft, it fell to the ground, nothing but the extremities of the bone remaining; the missing parts were thrown out at right angles to the target for a distance of six feet and a large splash of blood and marrow, eight inches in diameter, remained on the target as evidence of the shock. At a distance of 50 yards, then, Smith's results with the Lee-Metford rifle show that direct hits of bones invariably result in pulverizing, smashing and fissuring them—the resistance of the surrounding periosteum being apparently without influence on this result. Even at longer distances, simple grazes of bone may result in complete transverse fractures, or, in case the resistance is somewhat less great, extensive splintering, at least, will occur. At a distance of 1000 yards the Lee-Metford bullet may, according to Smith, cut a clean hole through a bone and leave its track filled with bone-dust, but even here his cuts show frequent fissuring and large splinters.

Captain Smith, among others, makes one suggestion which appears to be a very good one. He draws attention to the fact that in wars with savages who, as is well known, experience very little shock from gunshot wounds, especially small flesh wounds of the upper extremities, such shots would scarcely suffice to disable them, but would leave them, for a time at least, just as dangerous as they were before. One of the lessons which may be derived from the experiments with the new projectile on bones would be to aim at the lower extremities, and it certainly would appear impossible for even a savage to travel with a fractured bone in any part of the lower extremities.

For the purpose of illustrating the purely penetrative effect of the new projectile, produced anywhere between 500 and 2000

meters, we here reproduce a photograph by La Garde that shows this effect very well. (See Photo. *E.*)

Captain La Garde experimented with the "experimental" Springfield rifle which is a 0.30 caliber gun, the projectile of which has an initial velocity of 2000-foot seconds; its projectile is made of a German-silver jacket, filled with a core of lead, and is not cannelured nor lubricated; weight 220 grains. This illustration gives you a fair idea of what occurs to a long bone beyond the zone of explosive effect when it is hit with one of the new projectiles—barring, of course, exceptions.

Our army officers have, as you may know, decided in favor of the Krag-Jorgensen model.

We will conclude this discourse with a few remarks on *Bullets* and *Bacteria.* Both are enemies of human life.

Bullets are artificial products, devised by human ingenuity, and in themselves dead matter. Bacteria are the living enemies of human life, being the product of vegetable life. While, then, the two have nothing in common with each other, so far as their origin and composition is concerned, in gunshot wounds we may find both associated for one common end—the destruction of human life. It was formerly erroneously held that the bullets were sterilized, that is, made free from bacteria by the heated gases produced in the combustion of the explosive material as well as by the heat produced from friction in the passage of the projectile through the air. Moreover, the heat produced when the projectile collided with some resisting object, was also believed by some to kill the bacteria that might adhere to it or to the object struck. This idea, however, has been disproved by experiment. Thus, Dr. B. von Beck, of the fourteenth Army Corps of Germany, among other important experiments, conducted some with a view to determining the amount of heat imparted to the hard bullet of small caliber having a mouth of steel or copper. He fired into a target made of boards and thin sheets of iron arranged alternately about an inch apart. The projectiles were recovered as quickly as possible after firing, never allowing more than ten seconds to intervene between the firing and the recovery of the projectiles, which were dropped into 300 grams of mercury in a paper box 7 cm. high and 3 cm. wide. By means of a cork fixed on the bulb of a thermometer he held the projectile under the mercury and noted the rise of the temperature of the metal. He found:

PHOTO. E.

FIG. 1.—Gunshot injury of the lower third, right femur, by the .″30 caliber German silver jacketed projectile with the velocity common at 1,200 yards. The projectile perforated the anterior face of the bone about its middle, immediately above the upper margin of the articular surface, making a clean-cut perforation. The fissure occurred in drying, it was not present in the recent state.

FIG. 2.—A posterior view of Fig. 1.

Temperature of the leaden bullet of .45 caliber when recovered, 69° C.

Temperature of the leaden bullet of .30 caliber covered with steel, 78° C.

Temperature of the leaden bullet of .30 caliber coverered with copper, 110° C.

When we think that the resistance offered to the projectiles in these experiments was from three to four times as great as that offered by the human body, we must agree with him when he says that the theory that certain characters of the injuries produced by the projectiles are due to heat is no longer tenable. He believes that the periphery of the projectile alone is heated because the act of heating is so instantaneous that it could not be conducted into the interior.

It has been proven experimentally, and is now beyond doubt, that neither the heat produced by the combustion of the explosive substance in the barrel, nor that caused by the friction in the air, nor even that caused by the collision of the ball against some resisting object, is sufficient to sterilize the projectile; in other words, free it from any bacteria with which it might be infected at the time.

Dr. Messner, of Wiesbaden, has recently tested this question by infecting bullets with pus-forming organisms; these were fired into sterilized gelatine, and in every case infection occurred from these specific and morphologically easily recognized and distinguished microbes. Varying the experiments somewhat, he caused the bullet to pass through pieces of clothing infected with certain microbes before entering the sterilized gelatine. This also most always was found to result in the infection of the gelatine. Finally, Dr. Messner used sterilized bullets and found that even they, in passing through the air, would sometimes but not always become infected and carry infection into the wounds they made.

Captain La Garde, on examining bacteriologically the bullets in their original packages, found that 53 per cent. of them were absolutely sterile, that is, entirely free from bacteria, and that fact explains also to a certain extent why certain gunshot wounds have failed to produce infection, and why surgeons generally believed that the gases of combustion sterilized them. This sterile condition of the projectiles is believed to be owing to the cleanly meth-

ods that are used in their manufacture. In experiments with artificially sterilized bullets and guns firing into sterilized cotton, Capt. La Garde never got an infection. In all his other experiments with infected bullets, he invariably obtained an infection, not only of the sterilized gelatine, but also of certain animals which were fired into.

Although La Garde's experiments with the bacillus of tetanus proved unsuccessful in causing artificial lock-jaw, a case is reported by Habart, in which undoubted symptoms of lock-jaw were present before death, although no microscopical examination was made to verify the diagnosis.

The dangers from infection, then, in connection with gunshot wounds remain as great as ever, and antiseptic surgery will play a still more important rôle in future wars than it has heretofore. If even the dangers to life and limb have become greater, antiseptic surgery of to-day is more than a match for this increase, and we believe with the great Billroth, who says that "with clean hands and consciences the youngest military surgeons will now-a-days accomplish better results than were formerly attained by the most learned professors."

With regard to the subject of "First Aid to the Injured," Delorme says that a personal wound-package to be supplied to every soldier is still more necessary to-day than it was before; and Kipper strongly emphasizes the necessity for the instruction of every soldier in the principles of First Aid and personal hygiene. According to Habart, nothing much can be done directly in the rear of the line of fire, and the chief object is not first aid so much as the first safe transport. If the wounded can be brought under the roof of a protected tent as quickly and safely as possible, then of course, with antiseptic means, it may be possible to reduce the mortality to as low a figure as 1½ per cent., which figure has actually been attained by Mosetig, Fraenkel, Maidle and Fillenbaum in Servia and Bulgaria in 1885–6.

Haase thinks that the first dressing-station may safely be about 2400 meters behind the line of fire, instead of 4000 meters, as the order stands now. He also believes in the possibility of transporting the wounded during an action, instead of waiting until it is over. In Germany, the number of litter-bearers has been largely increased in accordance with the expected needs for an increased

number of wounded in the event of a war. Every company now has four stretcher-bearers and every battery two. Including the musicians, who are also trained to do service as bearers, every army corps has 1168 bearers, and when all the twenty German army corps are in the field, leaving out reserves, its sanitary corps, under command of medical officers, numbers 45,000 men. This number seems certainly most munificent, and, if there is no projectile that can be called *humane*, the nation that provides so generously for its wounded sons and defenders as that most certainly deserves this epithet.

The following is a list of references used in the preparation of the foregoing lecture, comprising the more important experimental results thus far attained :

1. CHAUVEL ET NIMIER : "Sur les effets des armes nouvelles (fusil modèle 1886 dit Lebel), et des Balles de pétit calibre à enveloppe résistante." *Compl. rem. Acad. d. sc.*, Par., 1888 ; cvii, 56–58.

2. CHAUVEL, NIMIER, BRETON ET PESME : "Recherches experimentales sur les effets des armes nouvelles et des balles de petit calibre à enveloppe résistante." *Arch. gen. de méd.*, Par., 1888 ; ii, 385–410.

3. DELORME: "Notes sur les lesions produites par la balle des fusil Lebel." *Gazette des hop.*, Par., 1888 ; lxi, 587.

4. DELORME (E.) ET CHAVASSE : "Étude comparative des effets produits par les balles du fusil Gras de 11 m. m. et du fusil Lebel de 8 m. m." *Arch. de méd. et pharm. mil.*, Par., 1891.

5. HABART : "Zur Frage moderner Kleincaliber-Projectile." *Wien. med. Presse*, 1889 ; xxx, 988–993.

6. HABART : "Die Schusseffekte kleinkalibriger Kriegsgewehre." *Internat. klin. Rundschau*, Wien, 1892 ; vi, 931–935.

7. HABART : "Das Klein-Kaliber und die Verwundeten-Versorgung im Felde." *Internat. klin. Rundschau*, Wien, 1894 ; viii, 302–305.

8. HICLET : "Effets comparés de projectiles de l'ancien et du nouveau fusil de guerre ; quelques considerations relatives au fonctionnement du service medicale et a l'intervention de la chirurgie dans les place sanitaires de première ligne." *Arch. med. Belge*, Brux., 1892 ; 3 s., xlii, 84–113.

9. KIKUZI (Z.) : "Untersuchungen über die physikalische Wirkung der Klein-Gewehr-Projectile, mit besonderer Berücksichtigung des Kaiserlich-Japanischen Ordonnanz-Gewehres, Syst. Murata." 8vo, Tübingen, 1890.

10. KIPPER : "Das moderne Geschoss im Zukunftskriege." *Internat. klin. Rundschau*, Wien, 1893 ; vii, 283–287.

11. KIRKER (G.): "A comparison of the cylindro-conoidal and round-bullet wounds." *Tr. Internat. Med. Congr.*, 7 Sess., Lond., 1881; ii, 578–583.

12. LANGENBUCH: "Ueber die erste Versorgung der Leichtverwundeten auf dem Schlachtfelde." *Deutsche Med. Woch.*, 1894, Nos. 11, 12.

13. LONGMORE (T.): "Some observations on wounds inflicted by the bullets of the Martini-Henry rifle." *Tr. Internat. Med. Congr.*, 7 Sess., Lond., 1881; ii, 583–586.

14. REYHER (CARL): "Ueber primäres Debridement d. Schusswunden." *Tr. Internat. Med. Congr.*, 7 Sess., Lond., 1881.

15. HAASE: "Ueber den Dienst der Verwundeten-Träger der Zukunftskriege." *Verh. d. Deutsch. Ges. f. Chirurgie*, 21. C., 1892.

16. VON BECK: "Ueber die Wirkung moderner Gewehrprojectile." Leipzig, 1885.

17. REGER (E.): "Ueber die kriegs-chirurgische Bedeutung der neuen Feuerwaffen." *Verh. d. Deutsch. Ges. f. Chir.*, 1892; xxi, 2, 19–57.

18. REGER: "Die Gewehr-Schusswunden der Neuzeit." Strassburg, 1884.

19. MARSH (T. A. P.): "A report of a case of gunshot-wound inflicted by a bullet from the new magazine-rifle." *Army-med. dep. report*, 1889, Lond.; xxxi, 425–427.

20. MEYNIER: "Contribution à l'étude des effets des nouveaux projectiles de petit calibre. Rap. de Chauvel." *Bull. et Mem., Soc. de Chir. de Paris*, 1888; n. s. xiv, 367–359.

21. MOROSHOFF: "Sur l'action destructive des balles modernes." *Rev. de Chir.*, Par., 1889; ix, 329.

22. STITT: "Report on wounds by Mannlicher bullets." *Med. Rec.*, N. Y., 1891; xli, 147.

23. WAGNER (V.): "Beiträge zur Kenntniss der Geschosswirkung des klein-kalibrigen Gewehres." *Klin. Zeit- u. Streitfragen*, Wien, 1892; vi, 299–346.

24. ANDREWS: "The impending revolution in military surgery caused by the new infantry-rifle." *Journ. Am. Med. Assoc.*, Chic., 1893; xxi, 955–959.

25. ALTABAS (I.): "Las heridas del nuevo fuzil." *Siglo Med.*, Madrid, 1893; 767–772.

26. VON BARDELEBEN: "Ueber die Kriegschirurgische Bedeutung der neuen Geschosse." 8vo, Berlin, 1892.

27. BOGDANIK: "Die Geschoss-Wirkung der Männlicher-Gewehre (Mod. 1888)." *Wien. Klinik*, 1890; xvi, 309–336.

28. BOVET: "Einiges über Wirkung klein-kalibriger Handfeuerwaffen, insbesondere des Hebler-Gewehrs, Modell 1887." *Corr.-Bl. f. Schweiz. Aerzte*, Basel, 1887; xvii, 746–751.

29. BRUNS (P.): "Ueber die Kriegschirurgische Bedeutung der neuen Feuerwaffen." *Verh. d. Deutsch. Ges. f. Chir.*, Berlin, 1892; xxi, pt. 2, 1–18.

30. BRUNS (P.): "Die Geschosswirkung der neuen Klein-Kaliber-Gewehre. Ein Beitrag zur Beurtheilung der Schusswunden in künftigen Kriegen." 4to, Tübingen, 1889.

31. HABART: "Die Geschoss-Frage der Gegenwart und ihre Wechselbeziehungen zur Kriegschirurgie. Eine kriegschirurgische Studie." 8vo, Wien, 1890. *Mith. d. K. K. Mil. San.-Com.*, i–iii.

32. PAVELOFF: "On the importance of the equipment of the army with small caliber weapons in military sanitary relations." 8vo, St. Petersburg, 1893.

33. LA GARDE (L. A.): "Notes on the effects of projectiles of large and small caliber on the human body, at Frankfort Arsenal, Pa., March, 1893." *Washington, Surgeon General's Report for* 1894.

34. SMITH (F.): "The effects of the Lee-Metford Bullet on the Bones of Horses." *Journ. Royal United Serv. Inst.*, London, 1894; vol. xxxviii, No. 91, 41.

STREET RIOT DRILL.

PREFACE.

The formations used in this drill were devised by Lieutenant W. F. Fullam, U. S. Navy. Some of the battalion movements were based upon the work of the late General Brownell, N. G. S. N. Y. The company movements are new. They are of special value, because, in dispersing a mob, it may at times be wise to assign each company of a battalion to a separate street with orders for all to rendezvous later at a certain point. In this manner a mob may be more effectually scattered than by keeping a battalion at all times intact.

The wall scaling maneuver was devised by Lieutenant W. J. Maxwell, U. S. Navy, whose company of bluejackets on board the U. S. S. Vesuvius was so perfected in this exercise that it scaled a nine-foot wall in thirty seconds. Arrangements can be easily made for the instruction of squads in any armory.

The street riot formations are applicable to Army units; it is only necessary to note that the "section" in the Navy corresponds to the "platoon" in the Army, and that the 1st, 2d, 3d, and 4th petty officers have the same duties as the 2d, 3d, 4th, and 5th sergeants respectively.

ABBREVIATIONS.

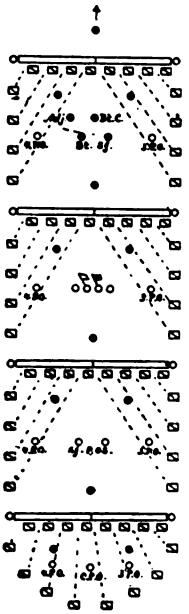
bg. c..........Brigade Commander.
bt. c..........Battalion Commander.
c. c..........Company Commander.
bt. sf.........Battalion Staff.
adj...........Adjutant.
c. o. s........Chief of Section.
c. p. o........Chief Petty Officer (Sergeant-Major).
1. p. o........First Petty Officer.
2. p. o........Second Petty Officer.
3. p. o........Third Petty Officer.
4. p. o........Fourth Petty Officer.

These formations and methods, with the new system of titles and abbreviations, will appear in the revised edition of the "Instructions for Infantry and Artillery, U. S. Navy," when the latter is published.

FORMATIONS FOR STREET RIOTS.

General Rules.

1. Each **c. c.**, **bt. c.** and **bg. c.** should have a map showing all the principal streets, squares, parks, and open places where a force may be rallied.



Civilian scouts, or men disguised in civilians' clothing, will keep the commanding officer informed as to the situation of affairs in the city.

A few pioneers with picks, crowbars, shovels, and axes will accompany the command.

Squads may advance along the housetops or in rear of the houses whenever practicable and necessary to secure a flanking position against a barricade, or to command the windows of the houses opposite.

Pieces will be carried with the bayonets fixed, and habitually at *port arms*.

It is essential that perfect control of the fire be maintained to prevent unnecessary loss of life. A few selected marksmen should be ready at all times, under the direction of the officers, to pick off the leaders of the mob.

To Protect the Flanks in Column.

2. Being in column of companies: 1. *Twos and fours, rear rank, as flankers*, 2. MARCH.

PLATE 1, Par. 2.

The numbers designated place themselves on the flanks; those of the right section on the right flank and those of the left section on the left flank, at equal intervals between their own company and the one next in rear. The **3. p. o.** of each company controls its right flankers, and the **4. p. o.** its left flankers;

the former watches the windows and houses on the left side of the street, the latter those on the right side. The flankers

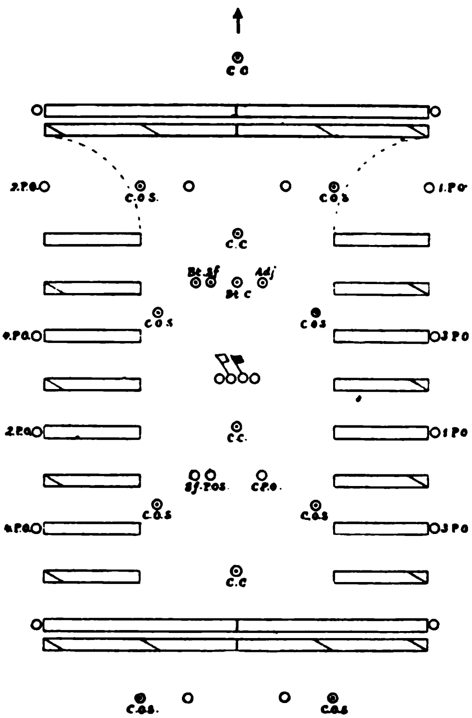


PLATE 2, Par. 3.

of the rear company form a semi-circle in its rear, facing about whenever necessary to fire. Scouts may be detailed under the command of an officer or **p. o.** to precede the column.

At the command: 1. *Flankers*, 2. POSTS, the flankers resume their places in the rear rank. (Plate 1.)

To Form Battalion Square.

3. Being in column of companies: 1. *Form battalion square*, 2. MARCH.

If at a halt, the leading company stands fast; the right sections of interior companies execute *right forward, fours*

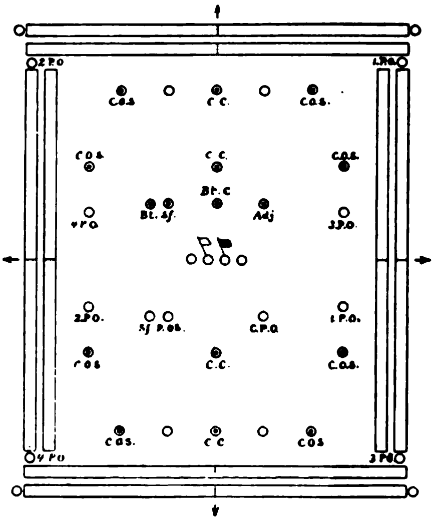


PLATE 3, Par. 4.

right, and the left sections *left forward, fours left*; the rear company closes up to form the rear of the square. (Plate 2.)

4. When the square is halted, the flank sections may form line facing outward, and the rear company may face about.

The color guard is posted inside the square. (Plate 3.)

5. To reform in column, the square being faced in the proper direction: 1. *Column of companies*, 2. *Right and left front into line*, 3. MARCH.

STREET RIOT DRILL.

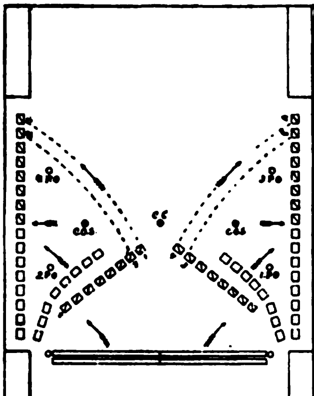


PLATE 4, Par. 6.

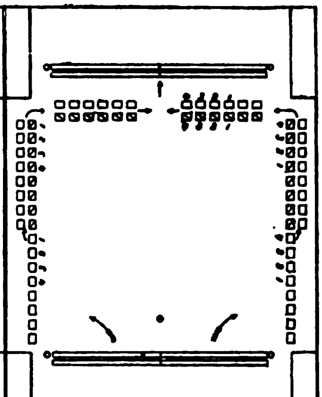


PLATE 5, Par. 7.

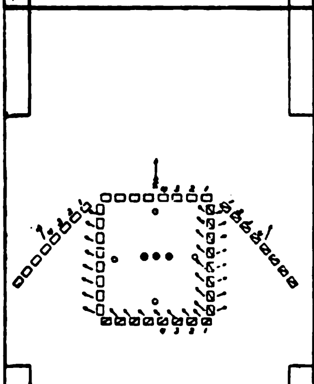


PLATE 6, Pars. 8–10.

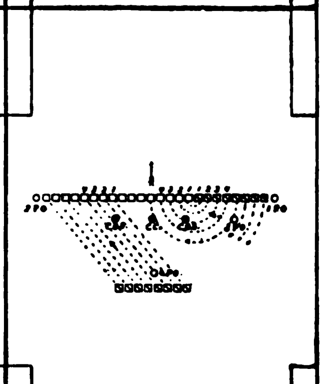


PLATE 7, Par. 13.

The flank sections form front into line; the first company advances, and the other companies take the short step and follow at the proper distance.

To Protect the Flanks at Street Crossings.

6. Being in column of companies, the flankers of the leading company are ordered into ranks, and the first company having reached the fence or building line: 1. *First company*, 2. *Sections right and left turn*, 3. *Double time*, 4. MARCH.

At the fourth command, the right section turns to the right, the left section to the left; the rear ranks oblique to the left and right, respectively, joining on the flanks of their respective front ranks to extend the line across the side street. During this movement, the *charge bayonet* will be taken, if necessary to force back the mob. The rear companies continue the march. The single ranks may be advanced along the side street, if necessary to clear it. Returning, they form as the rear company of the column. If the street does not cross, but ends at the one through which the column is marching, the whole of the first company turns to the right or left. (Plate 4.)

To Reform the Company in Column.

7. The sections being in line across the side street: 1. *Form company*, 2. MARCH, 3. *Forward*, 4. MARCH.

At the first command, the sections are quickly formed in double rank facing by the flank in the direction of the march; at the second command, the first section executes *column left*, the second section *column right*; as the heads of the sections are about to unite, the commands three and four are given, at which the sections execute *right* or *left flank*, and the company advances as the rear company of the column. (Plate 5.)

To Form Company Square.

8. Being in column of sections, marching or at a halt: 1. *Form company square*, 2. MARCH.

The front rank of the first section continues the march or stands fast; the rear rank faces about, and turns to the left in double time; the front rank of the second section turns to the left in double time; the flank men of the two ranks avoid each

other during the turn, and if marching, each flanker moves to the front as soon as he reaches his position in the square so as not to delay the march; the rear rank, second section, continues the march or faces about. Officers and **p. os.** may be inside or outside the square. The first and second **p. os.** have charge of the front ranks, and the third and fourth **p. os.** have charge of the rear ranks of their respective sections.

One or more men may be detailed from each side of the square to act as scouts or flankers.

The square may march *to the front*, *to the rear*, *by the flank*, and execute the *turn*, and the *oblique*. When halted, the men will face outward. At the command *forward*, the **c. c.** will indicate the direction of the march with his sword, and the **p. os.** will then face their respective sides of the square in the designated direction.

The color guard will take post inside the square. (Plate 6.)

9. Company being in line, marching or at a halt: 1. *Form company square*, 2. MARCH.

The front rank of the first section continues the march or stands fast; the rear rank faces about, turns to the left in double time and each man continues the march, or halts, when in position; the front rank of the second section faces about, turns to the left in double time, and each man continues the march, or faces about and halts, when in position; the rear rank of the second section faces about, obliques to the left in double time to its position in the square, faces to the front and continues the march, or halts.

To Form for Clearing a Street.

10. Being in company square, marching or at a halt: 1. *Flankers right and left front into line*, 2. MARCH.

Intervals are taken from the center, if necessary, to reach across the street; the rear side of the square remains in its place to protect the flanks and rear; the flankers execute *front into line* in double time, and the men in the front line advance at *charge bayonets*. (Plates 6 and 7.)

11. To reform the square: 1. *Form square*, 2. MARCH.

The flankers face to the rear, turn to the right or left into their places in double time, and continue the march or halt.

12. Company being in line, marching or at halt: 1. *Right flankers into line*, 2. MARCH.

The company continues the march, or stands fast; the rear rank, first section, faces to the right and the men successively

place themselves on the line of the front rank, in double time; the rear rank, second section, faces about, obliques to its position in rear of the center, in double time, and then continues the march to the front, or halts.

To Form Line from Formation for Clearing a Street.

13. Flankers being in line: 1. *Form company*, 2. MARCH.
The right flankers face to the left and successively resume their places in line, in double time; the rear rank, second section, obliques to its position in line in double time. (Plate 7.)

To Form Column of Sections from Company Square.

14. The square being in march or faced in the proper direction: 1. *Form column of sections*, 2. MARCH.
The flankers face inward and turn into their places in double time, avoiding each other during the movement; if marching, each man, when in position, moves to the front so as not to delay the march.

15. The company squares of a battalion may be used to clear parallel streets, each of which may be occupied by a company square during the advance.

To Form Line from Company Square.

16. 1. *Form company*, 2. MARCH.
Each rank turns or obliques, in double time, to its place in line; each man halts, or continues the march, when in his position.

Artillery.

17. Should artillery be detailed with a battalion for service in city streets, it will be assigned where its presence may be most needed. If necessary, squads of riflemen may be detailed from the infantry companies for its support.

WALL SCALING.

General Instructions.

18. This maneuver is designed for use in connection with the "Formations for Street Riots," and consists of a simple adaptation of "pyramids" to military purposes. As a maneuver, the practical limit of height is fifteen feet, but greater heights may be scaled by extending the principle when circumstances are favorable. This exercise will be of great practical value when men are compelled to advance in the rear of houses where walls and fences are encountered.

The unit adopted is the four. The **I. p. o.** mounts with the rear rank of the right four, the **2. p. o.** with the front rank of the left four, the **3. p. o.** with the rear rank of the right-center four, and the **4. p. o.** with the front rank of the left-center four. Officers mount as circumstances may require.

The front and rear ranks of each four mount independently, the rear rank mounting to the right of its own front rank.

For heights of ten feet or less, no special equipment is required; for greater heights a lanyard is provided.

The lanyard consists of a piece of twelve-thread manilla six feet long, with an eye large enough for a man's hand at one end, and a stopper knot at the other. Matthew Walker knots of spun yarn are worked on the lanyard at intervals of eighteen inches. When not in use the lanyard is bighted up and hooked to the left sling of the knapsack by means of a small eye worked on the lanyard.

To Mount.

19. Being in any formation: 1. *Wall to the front* (or, *in succession to the front*; or, *to the right, left*, or *rear*), 2. MOUNT.

At the first command, the subdivision, company, or battalion that is to mount first will be formed in line of squads along the wall at such intervals that the rear rank of each squad may form on the right of its front rank. At the second command, given when the rear ranks are so formed, all numbers except 4 of each rank, rest their pieces against the wall. 1 and 2 then approach the wall, face each other, advance their right and left feet respectively near the foot of the wall, place their right and left hands respectively against the wall, brace themselves, and then interlock the fingers of their free hands, palms up, thumbs pointing to the rear, thus forming a stirrup. 3 now places his left foot in the stirrup, his hands on the shoulders of 1 and 2, and then springs lightly up, placing his

right foot on the left shoulder of 1, his left foot on the right shoulder of 2, toes pointing to the right, his left hand against the wall; he then turns slightly, and with his right hand grasps the left hand of 4. (Plate 8.)

If on the retreat, the **p. o.** and 4 cover the movement, firing if necessary until their turns come to mount.

4 having grasped hands with 3, places his left foot in the stirrup, springs up, and places his right foot on the right

PLATE 8, Par. 19.

PLATE 9, Par. 19.

shoulder of 1; he then loosens the grasp of 3's hand, places his left foot in the right hand of 3, and, assisted by the latter, springs up, throws his right leg over the wall and straddles it. (Plate 9.)

In case the wall exceeds ten feet in height, 4 first grasps right hands with 3, places his right foot in the stirrup, then his left foot on the left shoulder of 2, loosens the grasp of hands, and places his right foot in the right hand of 3, who stoops and braces himself; 4 next places his left foot on the left shoulder and his right foot on the right shoulder of 3, who then slowly straightens up; 4 then grasps the top of the wall and straddles it as before. (Plate 10.)

4 having mounted the wall, 3, assisted by 4, then throws his left leg over the wall and faces 4. (Plate 11.)

The **p. o.** covers the retreat, or assists 4 to mount from the ground; he then mounts as described for 3, and, assisted by 3 and 4, passes over the wall and drops to the other side. (Plate 12.)

WALL SCALING.

PLATE 10, Par. 19.

PLATE 11, Par. 19.

PLATE 12, Par. 19.

PLATE 13, Par. 19.

2 then grasps hands with 3 and 4, and, assisted by 1, passes over the wall. (Plate 13.)

1 passes up the pieces to 3 and 4, who pass them to the **p. o.** and 2 on the other side; 1 then jumps, grasps hands with 3 and 4, and passes over the wall; 3 and 4 then drop to the ground. (Plate 14.)

PLATE 14, Par. 19.

PLATE 15, Par. 19.

When the height of the wall requires it, 3 and 4 drop their lanyards to 2 and 1 respectively, who assist the **p. o.** to mount and then pass up the pieces; 1 and 2 then haul themselves up, and all drop to the other side. (Plate 15.)

Having passed over the wall, the men form as directed.

To Fire while Mounting.

20. If advancing, or in pursuit, 3 standing on the shoulders of 1 and 2 looks over the wall to reconnoitre; the piece of number 4 may be passed to him and he may fire a few rounds, and then assist 4 to straddle the wall; the latter takes his piece from 3 and continues the fire; 3 then assists the **p. o.** to pass over the wall and gives him his piece; 2 then passes over, and the remaining pieces are passed to him; if necessary, each man takes cover and continues the fire as soon as he reaches the other side.

CORBESIER'S

SWORD EXERCISE

FOR THE NAVY.

PREFACE.

This exercise was prepared by Prof. A. J. Corbesier, Sword-master U. S. Naval Academy, assisted by Lieutenant W. F. Fullam, U. S. Navy. It was designed specially for the Navy, the aim being to provide a simple exercise with a sufficient number of movements for practical purposes.

The *parries* are such as to afford the best protection, and, at the same time, are carefully designed to facilitate quick counter attacks.

The *attacks* involve the thrust instead of the cut. By this means the offensive power of the weapon is more fully utilized, and the aggressor is not uncovered as he must inevitably be in making the swinging cuts in former systems. The hand and sword are nearly always in front of the body and directed toward the opponent—the position of perfect readiness either for attack or defense.

By direction of the Bureau of Navigation, Navy Department, this system was given a trial in the Naval Review Squadron commanded by Admiral Gherardi, and also in the squadron commanded by Admiral Walker. In both cases, the reports were decidedly favorable, and recognized the superiority of the new exercise.

The illustrations are from photographs taken by Lieutenant A. M. Knight, U. S. Navy.

SWORD EXERCISE.

1. In this exercise, all attacks are made by thrusting with the point of the sword, instead of attempting to cut with the edge. The attack with the point is more deadly, and there is less exposure to counter attack than there is in making the slashing blows that alone render the edge effective.

2. For instruction, the men form in one or two ranks facing to the front, swords at the *order* ; intervals and distances are taken as in the bayonet exercise; swords are brought to the *carry* at the preparatory command for marching, and are brought to the *order* on halting.

3. In the exercise, the sword is held in the right hand, thumb along the back of the gripe and almost touching the guard, the fingers united underneath, holding the hilt rather loosely.

4. Movements that may be executed in the same general manner toward either flank, are explained as toward but one flank, it being necessary to substitute the word "left" for "right", or the reverse, to have the commands and explanation for the corresponding movement toward the other flank.

The Moulinets.

1. *Sword exercise*, 2. MOULINET.

5. At the first command, raise the sword to the height of the right shoulder, edge to the right, back of the hand up, arm extended to the front; at the same time make a half face to the left, the right toe square to the front, feet at right angles, heels together, and carry the left hand to the small of the back, body erect, eyes to the front. At the second command, drop the point to the left and describe a full circle without bending the arm, the sword grazing the left shoulder, opening the fingers to give play to the hilt, and resume the original position; then reverse the hand, finger nails up, edge to the left, and execute a moulinet to the right of the body in a similar manner, continuing the moulinets alternately. At the command: 1. *Order*, 2. SWORDS, resume the *order*.

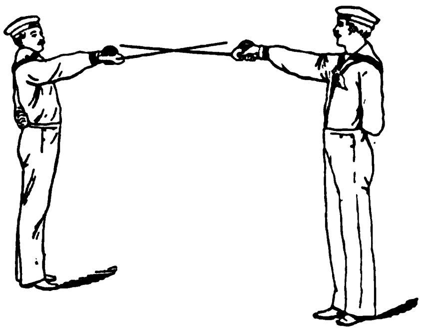


PLATE 1, Par. 5.

SWORD EXERCISE.

The Guards.

1. *Sword exercise*, 2. GUARD.

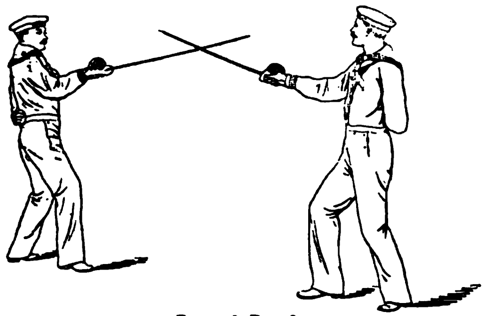


PLATE 2, Par. 6.

6. The first command is executed as in the moulinets. At the second command, bend the forearm and bring the hand to the height of the right nipple and in front of the right shoulder, the elbow free from the body and slightly outside the hip, the point of the sword at the height of the chin, edge to the right; at the same time advance the right foot twice its length, bend both knees slightly, body erect, the weight thrown a little more on the

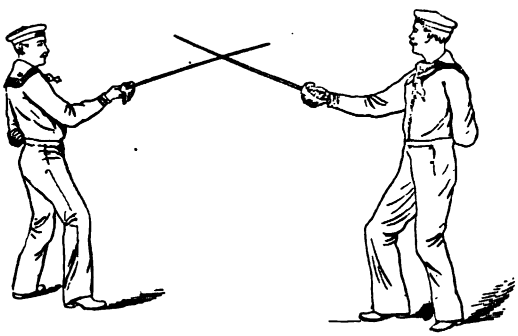


PLATE 3, Par. 7.

left leg than on the right, head erect, eyes to the front. This is the position of *right guard*. In the *left guard*, the sword is

held edge to the left, finger nails up, the hand opposite the center of the body.

7. To change guard: 1. CHANGE GUARD.

Reverse the position of the hand, raising the point and drawing the hand back slightly, to pass over, and close to, the point of the opponent's sword. (Plate 3.)

8. The attacks and parries *to the left* are made from the position of *right guard* only, and *vice versa.*

9. The *head attack* and *parry* are made from the *right guard* only.

10. The *thrust attack* and *parry* are made from either guard.

The Steps.

1. *Step*, 2. FRONT (or REAR, RIGHT, or LEFT).

11. Executed as in the bayonet exercise. In the engagement and assault, one opponent steps front when the other steps rear, and one steps right when the other steps left.

The Parries.

1. *Head*, 2. PARRY.

12. Carry the point of the sword a little to the right, then drop it to the left and raise the sword quickly a few inches above the head, edge up, hand in front of the right ear, the point to the left, the sword inclined slightly downward.

1. *Right* (or *left*) *cheek* (or *neck*), 2. PARRY.

13. Carry the hand about ten inches in front and three inches to the right of the right cheek, edge to the right, point up, sword inclined slightly to the front.

For the *neck parry*, lower the hand a few inches.

1. *Right flank*, 2. PARRY.

14. Describe a semi-circle from left to right with the point of the sword until it is a little to the right of the right knee, edge to the right, the hand to the right of the right hip and five inches below the right nipple, arm slightly bent.

1. *Left flank*, 2. PARRY.

15. Carry the hand and sword downward and to the left, the hand at the height of the waist and in front of the center

of the body, back of the hand up, the flat of the sword against the opponent's sword, point inclined to the left and slightly elevated.

1. *Thrust*, 2. PARRY.

16. If the attack is *to the right*, and in the high line, take the *right cheek parry*; if in the low line, take the *right flank parry*.

If the attack is *to the left*, and in the high line, shift the hand from right to left across the body and parry with the back of the sword; if in the low line, take the *left flank parry*.

17. Attacks at the leg are not parried with the sword, but by moving the right toe to the rear of the left heel, legs extended; at the same time carry the upper part of the body

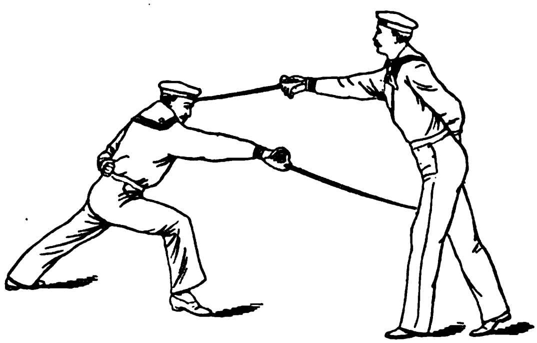


PLATE 4, Par. 17.

forward and attack the opponent's head or cheek. This movement will be executed at the command: 1. *Right foot to the rear*, 2. *Head* (or; *Right*, or *left*, *cheek*), 3. ATTACK. (Plates 4 and 5.)

Single Attacks.

18. All single attacks are made in two motions, the first motion being to disengage and extend the arm quickly in the direction of the attack; the second motion is a *lunge* and quickly follows the first.

19. The command *attack* (or *return*) is the signal for the first motion, and the command *lunge* for the second motion.

20. A *feint* is made by omitting the second motion, or lunge.

21. In all attacks, except the *thrust*, disengage by drawing back slightly and reversing the hand, the point passing over and close to the opponent's sword, and then extend the arm quickly.

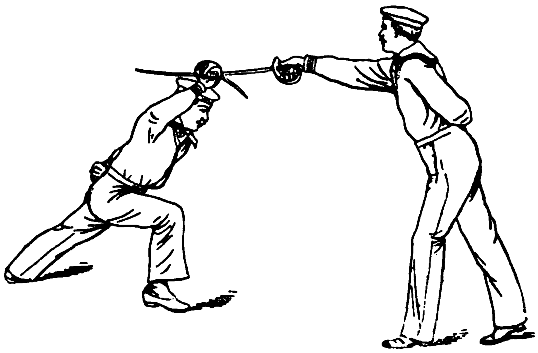


PLATE 5, Par. 17.

22. In the *thrust attack*, disengage by dropping the point below and to the opposite side of the opponent's sword, and reverse the hand, if the guard is *to the left*; if the guard is *to the right*, the hand is not reversed.

23. Having executed the first motion of an attack: 1. LUNGE.

Carry the right foot forward about eighteen inches, grazing the ground; extend the left leg, body thrown slightly forward, head thrown slightly back, left hand remaining at the small of the back.

24. The *lunge* will be executed in all attacks. In making an attack, the right hand is so held as best to oppose a counter attack.

25. To resume the guard: 1. GUARD.

Bend the left knee, carry the right foot quickly to its original position, throwing the weight of the body on the left leg, and resume the *guard*.

26. Being at the right guard: 1. *Head*, 2. ATTACK.

At the second command, disengage and extend the arm quickly, sword edge down, and point at the opponent's forehead, hand at the height of the shoulder. (Plate 6.)

27. Being at the left (or right) guard: 1. *Right* (or *left*) *cheek* (or *neck*), 2. ATTACK.

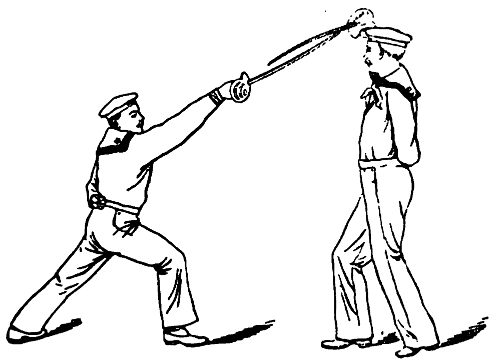


PLATE 6, Par. 26.

At the second command, disengage and extend the arm quickly, sword at the height of the cheek, or neck, edge to the

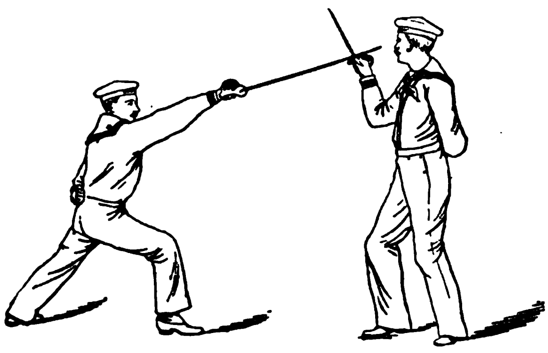


PLATE 7, Par. 27.

right, and point directly for the middle of the face, or neck. (Plates 7 and 8.)

28. Being at either guard: 1. *Thrust*, 2. ATTACK.

At the second command, disengage and extend the arm quickly, sword at the height of the breast, edge always to the right. (Plate 9.)

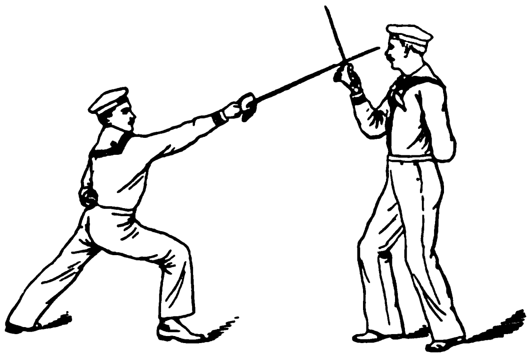


PLATE 8, Par. 27.

29. Being at the left (or right) guard: 1. *Right* (or *left*) *flank*, 2. ATTACK.

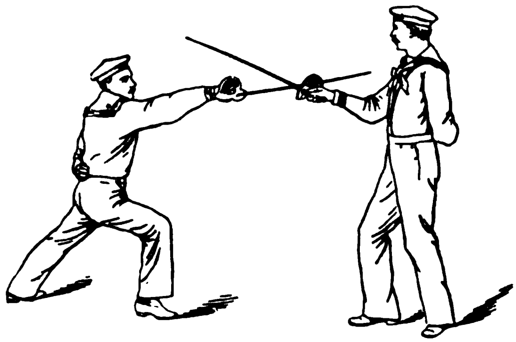


PLATE 9, Par. 28.

At the second command, disengage and extend the arm quickly, lower the point to the height of the belt, edge to the right, and point at the flank. (Plates 10 and 11.)

30. **After all attacks for the face, neck, or body, press with the thumb on the hilt and then withdraw the sword in an oblique direction to obtain a clear cut.**

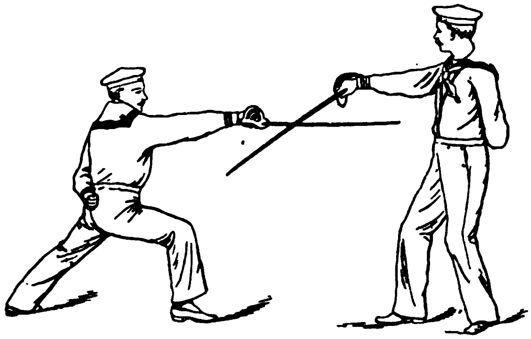


PLATE 10, Par. 29.

31. **The parries and attacks are first taught separately and afterwards in combination, thus:**

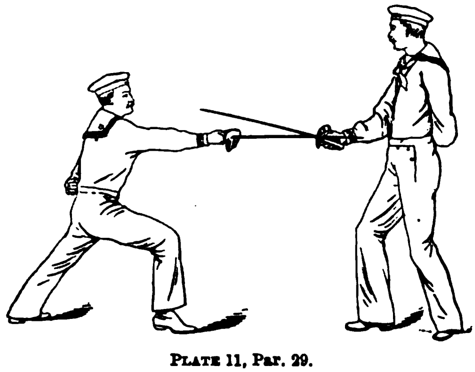


PLATE 11, Par. 29.

1. *Head*, 2. PARRY (or ATTACK), 3. GUARD, etc.
1. *Head*, 2. ATTACK, 3. LUNGE, 4. GUARD, etc.

1. *Left cheek*, 2. ATTACK, 3. LUNGE, 4. *Right flank*, 5. PARRY, 6. GUARD, etc.

Returns.

32. The attacks from the positions of the parries are called *returns*, and are made as follows:

After the head parry: 1. *Head* (or, *Left cheek, neck*, or *flank*), 2. RETURN.

At the second command, describe a quarter-circle with the point above the head from left to right by way of the rear without disturbing the position of the hand; when the sword points directly to the rear reverse the hand, bringing the edge to the left, extend the arm quickly and finish the movement as for the head, cheek, neck, or left flank attack.

33. After the cheek or neck parry: 1. *Right* (or *left*) *cheek* (*neck*, or *flank*), 2. RETURN.

Throw the point slightly to the rear to clear the point of the opponent's sword, then quickly turn the back of the hand up (or down) and attack in the designated direction.

34. After the right flank parry: 1. *Thrust*, 2. RETURN.

Raise the hand, nails down, extend the arm quickly and thrust for the face or the upper part of the body.

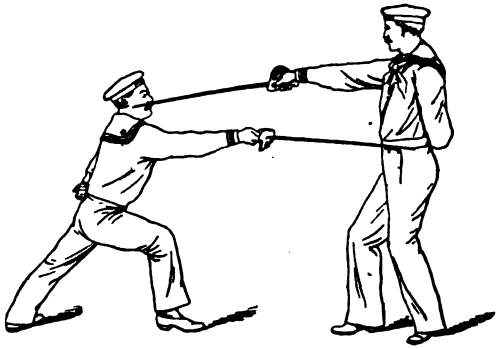


PLATE 12, Par. 35.

To parry this return, raise the sword, point to the left, and take the *head parry*.

35. After the left flank parry: 1. *Thrust* (or *Right cheek*, or *neck*), 2. RETURN.

Raise the hand and sword, edge to the right, leaving the sword of the opponent underneath, and attack in the designated direction.

To parry this return, drop the point of the sword and take the *head parry*. (Plate 12.)

36. After the thrust parry to the right, in the high line; 1. *Left cheek* (*neck*, or *flank*), 2. RETURN.

Executed the same as after the right cheek parry.

After the thrust parry to the right, in the low line, the return is the same as after the right flank parry.

37. After the thrust parry to the left, in the high line; 1. *Right cheek* (or *neck*), 2. RETURN.

Attack in the designated direction leaving the opponent's sword underneath.

To parry this return, drop the point of the sword and take the *head parry*.

After the thrust parry to the left, in the low line, the return is the same as after the left flank parry.

38. The *parries, attacks*, and *returns* will next be taught in combination, thus:

1. *Left flank*, 2. PARRY, 3. *Thrust*, 4. RETURN, 5. LUNGE, 6. GUARD.

1. *Thrust*, 2. ATTACK, 3. LUNGE, 4. *Right cheek*, 5. PARRY, 6. GUARD.

1. *Head*, 2. ATTACK, 3. LUNGE. 4. *Left cheek*, 5. PARRY, 6. *Right flank*, 7. RETURN, 8. LUNGE, 9. GUARD, etc.

Compound Attacks and Returns.

39. A compound attack, or return, consists of a *feint* followed by an *attack* or *return*, and will be taught after proficiency is attained in single attacks. For example:

Being at right guard: 1. *Left and right cheek*, 2. ATTACK, 3. LUNGE, 4. GUARD.

At the second command, feint for the left cheek, at which the opponent begins to parry *left cheek*; then reverse the hand quickly and attack the right cheek.

40. Being at head parry: 1. *Left and right cheek*, 2. RETURN, 3. LUNGE, 4. GUARD.

At the second command, feint for the left cheek, at which the opponent begins to parry *left cheek*; then reverse the hand quickly and attack the right cheek.

[illegible]ISE.

[illegible]ment.

[illegible] the foregoing principles and [illegible] be taught. The men will [illegible] and the front rank will then

[illegible], the front-rank men, in [illegible] themselves in front of [illegible] a distance that the swords [illegible] on guard.

[illegible]s' swords will be held edge

[illegible]gnated in the command; the [illegible]rry and *return*.

[illegible] at a *feint*, or at the first

[illegible] Single Attacks.

[illegible] 2. *Step*, 3. RIGHT.

[illegible] designated rank executes *step* [illegible].

[illegible] 2. *Head*, 3. ATTACK, 4. LUNGE,

[illegible] the designated rank will attack and [illegible]

[illegible] Attacks and Single Returns.

[illegible]k. 2. *Head*, 3. ATTACK, 4. LUNGE, [illegible] RETURN, 7. LUNGE, 8. GUARD.

[illegible] the designated rank will attack, and [illegible]. At the sixth command, the rank [illegible] and the opposing rank will parry.

[illegible] Compound Attacks and Single Returns.

[illegible] rear) *rank*. 2. *Left and right cheek*, 3. AT-[illegible] 5. *Left cheek*, 6. RETURN, 7. LUNGE,

[illegible] command, the designated rank will feint and [illegible] other rank will parry left and right cheek. At

the sixth command, the rank attacked will return, and the opposing rank will parry.

Examples in Single Attacks and Compound Returns.

45. 1. *Front* (or *rear*) *rank*, 2. *Head*, 3. ATTACK, 4. LUNGE, 5. *Left and right cheek*, 6. RETURN, 7. LUNGE, 8. GUARD.

Examples in Compound Attacks and Compound Returns.

46. 1. *Front* (or *rear*) *rank*, 2. *Right and left cheek*, 3. ATTACK, 4. LUNGE, 5. *Right and left cheek*, 6. RETURN, 7. LUNGE, 8. GUARD.

47. To repeat a movement, the commands of execution alone need be repeated: for example, to repeat the last movement: 1. ATTACK, 2. LUNGE, 3. RETURN, 4. LUNGE, 5. GUARD.

The Assault.

48. After careful instruction in all the principles and movements of the engagement, the instructor may permit the men to engage at will at the command *assault*, provided that an outfit of masks is supplied for this purpose. The men must be cautioned to move the hand and sword as little as possible from the position of *guard*, in order to keep themselves covered; to watch the hand of the opponent instead of his eyes, and to attack close to his sword.

49. To discontinue the engagement or assault, the instructor will command: 1. *Order*, 2. SWORDS, at which the men will resume the *order*.

The men are assembled as in the bayonet exercise.

To Dismiss.

50. Having assembled: 1. *Carry*, 2. SWORDS, 3. DISMISSED.

NOTICE.

Copies of the "STREET RIOT-DRILL, WALL SCALING AND CORBESIER'S SWORD EXERCISE," bound together in pamphlet form, may be purchased from the U. S. Naval Institute, Annapolis, Md. Price 30 cents.

PROFESSIONAL NOTES.

NAVAL WAR COLLEGE.

SKETCH OF PROPOSED SUMMER COURSE.

It is proposed that the governing principle of the Summer Course of 1894 at the Naval War College shall be a *Problem* of Warfare set before the officers engaged in the Summer work. This problem will be under their consideration during the whole term, and each officer will be invited to offer a solution at the close of the term—or groups of officers may be formed to present results of united efforts for such solution.

This *Problem* is the topic, toward the solution of which all the Summer work, except in International Law, should be directed. The lectures, the practical exercises, the personal examination of localities, will be so arranged as to converge throughout the course toward this problem at the close. In other words, such things will be learned and practiced as will better enable the officers to thoroughly master the material situation presented in the Problem.

In the *Problem* for this Summer, the aim has been to concentrate attention upon the strategic localities adjacent to the War College, and to make the hypothetical case a possible one.

It is perhaps unlikely that an enemy would land an Army Corps upon our shores, but it is possible—not for purposes of invasion indeed, but to protect some naval base, while the land force would be itself secured by the presence of the fleet near by.

It introduces further a feature in the situation which is useful for purposes of study and discussion.

The operations to be considered are divided for convenience into the three branches of Strategy, Tactics, and Naval Coast Defense. Under these heads, fall minor subjects to be studied and discussed, such as signalling, torpedo tactics and tactics of the ram ; camps and operations on shore of our seamen and marines ; types of ships to be used in the *Problem* ; strong bowed vessels for ramming ; heeling of ships after being rammed ; types of yachts and tugs for torpedo-boat catchers and scouts ; how improvise rams from vessels in vicinity ; floating workshops ; cleaning bottoms ; types of engines of ships in the problem ; boilers struck by enemy's shot ; dislocation of boilers or engines when ramming ; accidents to torpedo-boat engines ; quick delivery of coal from bunkers to furnaces in action ; economy of coal ; possibilities of liquid fuel ; how best keep ready to move without undue expense of coal ; best coal attainable for campaign.

Care of the wounded under the conditions of the Problem ; best positions for temporary hospitals ashore in vicinity of probable engagements in Gardiner's Bay and Narragansett Bay ; base of hospital supplies ; general hygiene of the fleet in the Problem ; diet and clothing to assist endurance of crews during Winter campaign, especially crews of torpedo-boats ; best water attainable without distilling ; supplying the fleet and the shore stations of its base, look-outs, signal stations and hospitals ; coaling and provisioning torpedo-boats in Long Island inlets, Sakonnet River, Cuttyhunk, etc., etc., railroads to be used in bringing forward provisions and ammunition from perma-

This force moves upon Stonington and Groton, destroys New London bridge and occupies Fisher's Island.

Enemy can spare from Sandy Hook fleet, 2 line, 4 heavy cruisers, 2 scout-destroyers, 4 torpedo-boats, without fear of attack if our force remains in vicinity of New London.

Indicate change in our strategic plan to meet this demonstration.

Shall we risk being attacked or closely blockaded in Gardiner's Bay when Fisher's Island and Sound are occupied?

Shall we attack in Narragansett Bay?

Shall we take up new position near New Rochelle?

Shall we put to sea?

TACTICS.

Our force in Gardiner's Bay is ready by Nov. 15, when enemy's Halifax force appears.

We then occupy the line "Gardiner's Bay—Fisher's Island—New London." The enemy is with convoy in Buzzard's Bay for two days, keeping close touch with us by scouts, cruisers and torpedo-boats. This touch is never lost.

Discuss the situation as to tactics.

Shall we attack?

Night attack or day attack?

In what formation?

What can be done with torpedo-boats?

The enemy moves with convoy from Buzzard's to Narragansett Bay, and begins landing Army Corps. It disposes its heavy ships to guard both entrances, and guards north flank of convoy with some lighter vessels near Wickford.

Discuss this tactical situation.

Shall we attack during disembarkation?

Night or day?

In what formation?

The enemy, land and sea force, occupy Fisher's Island and Sound. Our Fisher's Island, Sound and New London vessels join fleet in Gardiner's Bay.

Discuss the tactics of this situation.

Shall we attack at Fisher's Island?

Or await attack in Gardiner's Bay?

Or retire by night to sea, or Narragansett Bay, or New Rochelle?

Or withdraw into Peconic waters and defend entrance?

Should we attack while enemy is moving along shore before it reaches Fisher's Island?

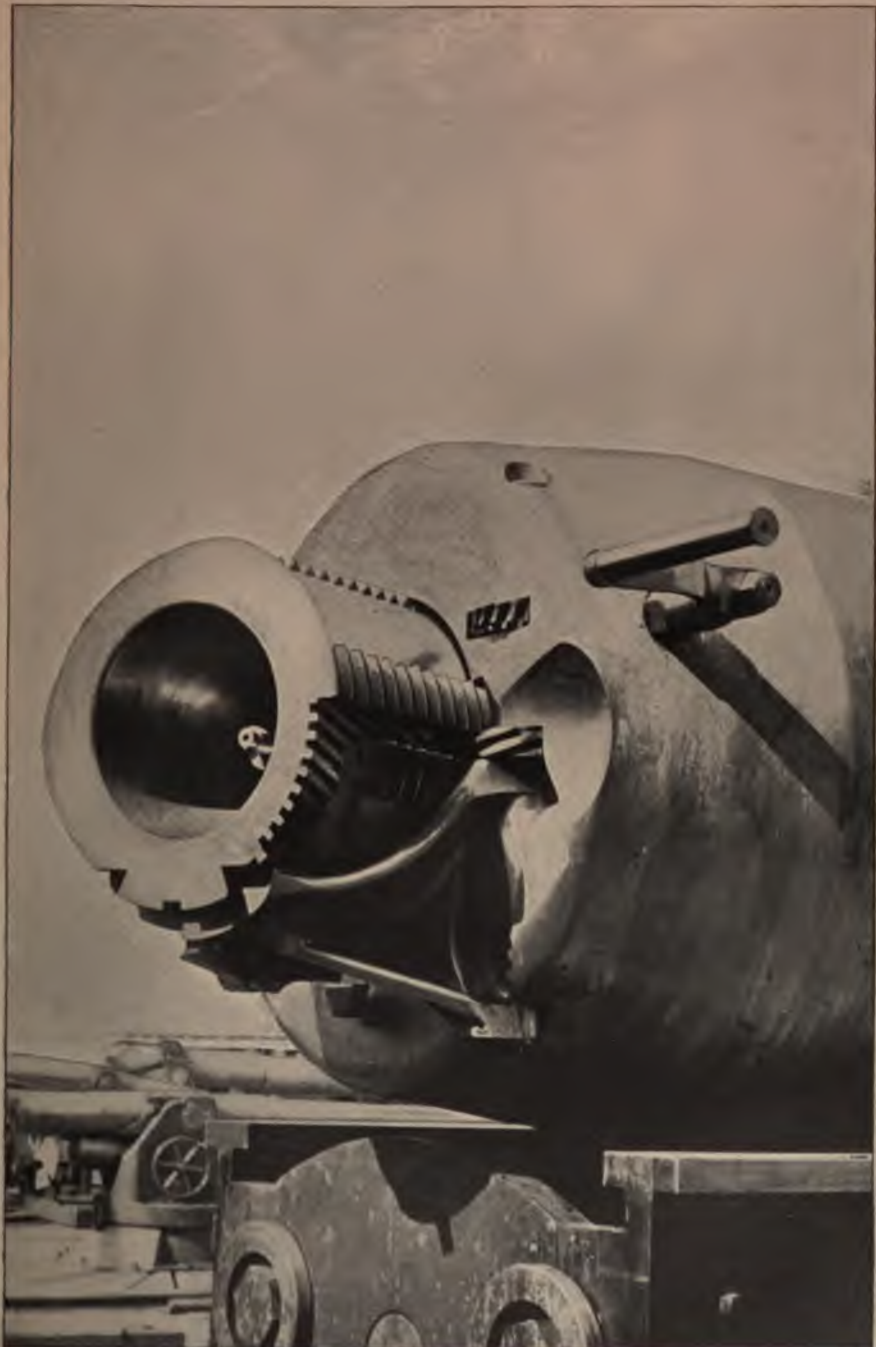
Plan the retarding of enemy's landing on Narragansett Pier—Wickford line, and prevention of the capture of Stonington and Fisher's Island by a body of our seamen and marines, etc., 5000 strong.

Plan, in best position, intrenched camp in Gardiner's Bay vicinity, to receive, drill and distribute marines to fleet, and to assist in defense.

COAST DEFENSE.

Expecting such a descent upon our coast and having one month to prepare, locate the stations for our lookouts from Cape Cod to Montauk, the system of signals between them and outlying picket boats, and locate telegraph lines to connect all stations with the central Admiral. Describe system of obstructing passages and shoals from Monomoy through the Vineyard sound. System of Submarine Mines—shelters for torpedo-boats and dynamiters.

During the time mentioned what can be done for local naval defense of ports and harbors, utilizing naval reserves, floating resources of ports, improvised mines?



Breech mechanism of the 13-in. B. L. R.

How make eastern entrance to New York harbor impassable for enemy's fleet by mines, obstructions, etc., while keeping it open for our own forces?

Prepare complete defense plans for Gardiner's Bay and vicinity—system of signalling and telegraph. Position of mines to defend entrance—shelters for torpedo-boats and dynamiters.

If compelled to withdraw to inner waters, such as Peconic Bay, fix anchorage there and plan protection and obstruction of Greenport channel.

Plan the provisioning and coaling of the fleet base in Eastern Long Island, and of all arms of the Naval Defense, torpedo-boat bases, lookout stations, etc., from central base at Brooklyn.

The same from New Bedford for Nantucket, etc.

The same for Narragansett Bay from Providence or Fall River.

Where establish central hospital?

PROOF OF 13-IN. B. L. R. AND MOUNT.

The first 13-in. B. L. R. of the U. S. Navy to be proved was safely transported from the Washington Navy Yard, and mounted at the Proving Ground in two working days of eight hours each. Two low trucks, with four steel wheels each, constructed especially for this calibre of gun, were used to carry it from the gun shop to the barge, and thence to its position on the turn-table at the Proving Ground. In order to allow for the inclination of a section of the track at the Proving Ground, the gun was turned over so that the saddle was bottom side up. The gun and saddle were turned over, lifted about 6 feet with the crane, transported in two directions at right angles to each other, for a distance of about 150 feet, and mounted on the slide, in eight working hours. If this time be compared with that required to mount a 10-in. B. L. R. at Annapolis, where the only appliances were jacks, hawsers and tackles, it will show a saving of 16 hours, although the weight of the 13-in. is more than double that of the 10-in. The hydraulic turret mount of the 13-in. is quite similar to that of the 10-in., having independent running out and in motors. The breech mechanism differs from those of the other B. L. R's, in that there are four sections of the interrupted screw on the plug and in breech-box, that the working mechanism of the breech-plug is contained principally in the metal of the gun itself, and that the weight of the mushroom and breech-block are, in proportion, much lighter than in the other designs. It requires, under *service* conditions, only two men on the crank handle, to open or close, the breech being closed with nine turns, and locked with nine turns of the crank-handle.

In the preliminary proof of the gun and mount, four rounds were fired, using DuPont's 13-in. brown pierced hexagonal powder, W. S., lot 1, the firing including the proof of the powder. Electric primers were used; the four cells of dry battery and the connections being installed on the rear of the slide, and the gun fired by compressing the handle on end of cable.

The following are the results of the firing:—

Charge 403 lbs., in 3 equal sections, gave 1720 f. s. muzzle velocity, and mean (maximum) pressure of 10.2 tons.

Charge 461 lbs., in 4 equal sections, gave 1851 f. s. muzzle velocity, and mean pressure of 12.3 tons.

Charge 482 lbs., in 4 equal sections, gave 1975 f. s. muzzle velocity, and mean pressure of 14.8 tons.

Charge 526 lbs., in 4 equal sections, gave 2003 f. s. muzzle velocity, and mean pressure of 17.1 tons. The gauges in the latter round did not agree closely; the maximum pressure recorded was 18.6 tons. The recoil of the gun was nearly the same in each round, varying between 47 and 47½ inches, the full recoil allowed by the design being 52 inches.

This sample of powder showed itself unsuitable for the 13-in., the specifications calling for 2100 f. s. ± 15 f. s. and a pressure not exceeding 15 tons; and has been rejected for that gun.

Everything about the gun worked perfectly. The mount worked fairly well, the only mishap being the bursting longitudinally of the main copper pressure pipe of the mount, on the second day of the trial. This was probably due to the "water hammer," and possibly to weakness of the pipe, though it had been previously tested with hydraulic pressure exceeding 600 lbs. Although the pressure was turned on gradually, when the pipes were filled, the practically sudden stoppage of the flow of water caused the "hammer," as the pressure was *maintained* at 600 lbs. per square inch by the accumulator.

This accident to the pipe, however, was repaired in one hour, so that the further working of mount was permitted, in the following manner: The pipe was tightly wrapped first with rubber cloth, and then with sheet copper, and covered over with No. 13 copper wire, in three layers. When pressure was again turned on, it was kept down to 400 lbs.; and although the pipe leaked, the mount was worked without any great difficulty.

The hydraulic sectional rammer worked well, putting the projectile "home" hard.

Regarding the motors of this mount, and all others of similar mounts, it is customary at the Proving Ground to take off the nuts from motor rods, and use the motors only for running out. Before firing, the motors are run back, as a matter of precaution.

At extreme elevation, which is the "loading position" with the mount at the Proving Ground, the holding-out clips are supposed to keep the gun in battery; this will depend in a great degree on whether the cone friction brakes of the clips are properly set up by the nuts on ends of the pivot, and all suspicion of oil or foreign matter is free of the brakes.

The box-slide of the mount at loading position rests upon two beveled composition plates, secured to the top of the ram cylinder.

The blast of the 13-in. under the muzzle is quite severe. It was sufficient to pull up a heavy T rail spiked down to a hard wood longitudinal, and more securely than in the case of a railroad, and throw it several feet away. A 12-in. shot weighing 850 lbs., lying under the muzzle and about 8 feet from it, was jumped off the ground. The surface of hard earth under the path of the projectile and about 8 feet from it, was scooped out in clouds of dust. From the above it would seem that on board ship, any ordinary deck planking 10 feet or 12 feet from the blast would most certainly be pulled up, or very seriously injured. The shock of the discharge is not so severe on the ears as that of the 8-in. B. L. R. using full charges, or even of the smaller calibres, on a calm day. Much would depend on the direction of the wind. The wave motion of the earth is quite long, as shown by the effects on objects near, as compared with that of lighter guns, and from reports of those living six and twelve miles distant, the discharge is exceedingly and threateningly heavy.

The official test was witnessed by a large number of people; and the interest taken in this, the largest modern gun made in America, seems quite general.

It is sufficient to say that no ship of to-day has armor that can resist the blows of its armor-piercing projectiles at a range of 1500 yards.

No experiments as to rapidity of loading have been made; but from observation, it would be safe to say that, including the necessary sponging, this gun could be fired eight times an hour, under *service* conditions. In the heat of competition, or of battle, this might be greatly exceeded; but the conditions in the turret of a ship and at the Proving Ground are very different. As the proof of guns of this calibre, manufactured by Americans, progresses, it will be interesting to compare the results with those of heavy guns built abroad.

R. D. T.

Discharge of the 13-in. B. L. R. (using a full charge of powder).

SPIRAL VERSUS FLAT MAIN SPRINGS IN GUNS.

In regard to the change from flat to spiral springs by the Hotchkiss Company, it is considered that flat springs are reliable to a certain extent, that they do good work, and are so arranged in the breech block as to be of easy access, in case of accident. From the normal position of the flat main spring, $3\frac{7}{8}''$ when open to $\frac{1}{8}''$ when closed, the minimum weight is 110 lbs. And this weight is distributed in the extremely short length of $9\frac{3}{4}''$. The prime cause of accidents, other than the natural tendency to break under this tremendous unnatural strain to which they are subjected, is the back fire from defective primers, and there are numerous records where the springs have been blown out, because of their exposed position. If the spring be blown out, in most cases a stirrup is broken, sometimes a firing-pin, and hammers have been known to break. In fact, the three parts may all be broken by one blow back. The actual cost, should this happen in a 6-pdr., would be hammer complete, $12.94, main spring $7.19, total $20.13.

There is, moreover, danger to person in replacing a flat spring, a case having happened where a naval officer nearly lost an eye in the act. The record of the spring was as follows: it had passed inspection for size and weight, had been closed in clamp, flat, for one week, reweighed and found all right, had been on the proving ground, tested under fire, and had a second test of 10 shots (because of experimental firing of a gun), and it broke in the act of being assembled for shipment. From a mechanical standpoint it is claimed that, all things considered, length of spring, its peculiar shape necessitated by the space it occupies, and the extreme action as compared with the amount of power required to explode a primer through $0.06''$ thickness of tough metal, it is very hard to explain why a flat spring of the given dimensions should live for any length of time.

As to the present arrangement of the spiral springs in Mark II., Hotchkiss R. F. Gun,—they are encased in a tube entirely out of the way of harm, can be dismounted and mounted quickly, with little trouble, and without danger to person. The length of action extends in the 1-pdr. through $44''$, in the 6-pdr., $63\frac{3}{4}''$. As to the life of spiral springs, they have run up to 285,000 vibrations. One of the most celebrated shotgun makers in the country has entirely discarded the flat springs for both main and sear. During the experiments that were made to ascertain the facts as to the expediency of the change, it was found that the longest life of the flat spring did not exceed 25,000, and that the spiral spring ran up to 625,000 before breaking. It is further stated that records are at hand where four spiral springs in a machine, that were $12''$ long, $1''$ diameter, made from wire $.094''$ diameter, had a vibration of $1\frac{1}{4}''$; and they have run up to what would seem the incredible number of over 15 millions. Taking these facts into consideration, one is compelled to have some faith as to the longevity of the spiral spring under continued action, and to believe that it would be safe to use it anywhere, where sufficient length could be had.

It is asserted that in mounting and dismounting the firing mechanism of the 1-pdr. gun (after the block has been removed from the breech-housing), the main-spring and sleeve, rock shaft and hammer may be taken out, the firing-point removed and replaced, and the whole assembled in eight seconds.

THE ROLLING OF BATTLESHIPS OF THE ROYAL SOVEREIGN CLASS.

[*The Engineer.*]

At a time when public anxiety has been aroused as to the conditions of stability appertaining to our most recent battleships, it is a comforting assurance to find two well-known authorities of so vast and wide-spread experience as

Mr. W. H. White, Director of Naval Construction, and Sir E. J. Reed, expressing a united conviction as to the absolute security of the Royal Sovereign class from any likelihood of capsizing. It is somewhat unfortunate that the two features, propensity to roll and liability to capsize, should be associated together in the minds of the unprofessional public; although, as clearly demonstrated by Mr. W. H. White in his "Manual of Naval Architecture," they have nothing to do with one another. He puts it thus:—"A *stiff* ship is one which opposes great resistance to inclination from the upright, when acted upon by some external force; a *crank* ship is one very easily inclined. A *steady* ship, on the contrary, is one which, when exposed to the action of waves in a seaway, keeps nearly upright, her decks not departing far from the horizontal. Hereafter it will be shown that frequently the stiffest ships are the least steady, while crank ships are the steadiest in a seaway." The ill-fated Captain, for instance, was remarkably steady under sail as well as under steam, and was by no means lively in a seaway or given to rolling. It is probable that the recent awful circumstances which have occurred in the capsize of the Victoria have so unhinged the nerves not only of landsmen but of sailors, that the distinctness of the two questions of rolling and stability has been momentarily lost sight of.

Whatever may, however, have been the events which contributed to the rather sensational view that has been taken of the rolling records exhibited by the Royal Sovereign, the Ramilies, the Resolution, and the Empress of India, we unhesitatingly endorse the opinions expressed by Mr. W. H. White and Sir E. J. Reed, viz., that the stability of these vessels has not been actually called in question. But, as the mere expression of these opinions, unaccompanied by any verification of the same, is not likely to carry weight with it, we propose to support our views by certain figures, which are calculated in the highest possible degree to allay the fears of the public. At the same time—although in deference to a sense of duty, we have deemed it advisable to touch upon the point of stability—we would point out that the rolling of the Royal Sovereign class is the subject matter of our present paper.

A glance at the statement which is annexed will show at once what are the "features of stability" possessed by the Royal Sovereign class, as compared with a very crank ship, the late Captain, and an ordinarily stiff ship, the Monarch. It is manifest that a height of freeboard which does not permit the edge of the deck to be immersed under an angle of heel of 27 deg. must give immensely greater stiffness than the corresponding 14 deg. of the Captain. The difference between the "moments of stability"—this being the force which tends to right the ship again when inclined—upon the heel of both vessels to the extent of their freeboard, is as 5700 to 24,096 foot-tons. But another, and fully as important an improved feature as found in the Royal Sovereign, is the raising of the height of the metacentre above the waterline to 5·6 ft., which also contributes partly towards the great increase of the moment of stability at 27 deg. heel. The increase in the height of the metacentre is due to the great beam possessed by these battleships. It is this feature, moreover, which gives the Royal Sovereign class such an immense advantage over the Monarch, both at the angle of immersion of the edge of the deck and at the angle of maximum stability. Although the Monarch is better off than the Royal Sovereign so far as regards the position of her centre of gravity, this being in the first-mentioned vessel below the waterline, yet the narrowness of the Monarch counterbalances the good position of her centre of gravity. Had it been possible to lower the centre of gravity in the Royal Sovereign class to the level of that of the Monarch, the angle of maximum stability would possibly have been 45 deg. instead of 37 deg., and the moment of righting force would have been quite as great, whilst the range of stability would have extended much further. A high centre of gravity must be the penalty of high command for heavy guns. Valuable as this character may be, however, it is not of such vital importance as considerable freeboard

and adequate beam, the latter being the factor which raises the position of the metacentre as before remarked. The Captain had a comparatively low centre of gravity, but its value was neutralized by the want of beam and freeboard in that unfortunately designed vessel.

To sum up in a few words the most striking features of our statement, the Royal Sovereign has a righting force of 30,000 foot-tons at her most stable angle of heel, viz., 37 deg., whilst the Monarch and Captain had only 15,000 and 7000 foot-tons respectively at their corresponding angles. The stability, therefore, of our great battle-ships has, we take it, been proven.

Now as to the rolling records of the Royal Sovereign class. Whatever may be our assurance as to the actual safety of these vessels, it is idle to disguise the fact that they roll unusually, and that as gun-platforms their usefulness is seriously interfered with by this propensity, whilst the discomfort of the officers and crew is very great. Upon the subject of rolling and its probable cure, most valuable remarks were made by Dr. Elgar in a paper read before the Naval Architects at Cardiff, and which appeared in THE ENGINEER for July 14, 1893. Dr. Elgar drew attention to the fact that, although rolling was quite a feature of the great transatlantic liners, and he believed that loss in speed was the natural result, that the great advantages of bilge keels—which had fully been recognized in the Royal Navy—"were not generally understood in the mercantile marine." He considered that any loss of speed resulting from the extra friction which might be due to the presence of bilge keels in still water, would be more than counterbalanced by the improvement in speed which would be created by the absence of friction due to rolling in a seaway. He went on to say:—"It would add greatly to the comfort of passengers if rolling could be reduced in these large steamers; and bilge keels furnish a ready and certain way of doing it, when they are properly fitted and are of appropriate size." It is somewhat significant that Mr. W. H. White, who was present at the reading of the paper alluded to, agreed with "what Dr. Elgar had said as to the utility of bilge keels, but he thought that Dr. Elgar would agree, as the size and height of ships increased, the useful effects of bilge keels must diminish, and in *experience* they had had instances in which no practicable bilge keels could have produced any appreciable effect."

Now, there is little doubt that Mr. W. H. White speaks with authority when he appeals to experience. But when these words were uttered, the untoward

Features of stability.	Captain.	Monarch.	Royal Sovereign.
Angle of heel at which the deck is immersed....................	14°	28°	27°
Amount of righting force in the above position (in foot-tons of moment)..	5,700	12,542	24,096
Angle of maximum stability	21°	40°	37°
Maximum righting force (in foot-tons of moment)......	7,100	15,615	30,000
Angle at which righting force becomes zero (range of stability)...	54⅛°	69½°	65°
Metacentric height (approximately)	3.1′	2.4′	4.0′
Height of metacentre above waterline (approximately)............	—1.2′	.1′	5.6′

experiences of the Resolution, of the Ramilies, and of the Empress of India, had not developed themselves, and we cannot but fear that such extreme coefficients, 40 deg. and 45 deg. of roll, had not been included in the formulæ upon which the Director of Naval Construction based his opinion as to the inadvisability of fitting bilge keels to large vessels. In point of fact it was quite clear that no such angle of heel as even 40 deg. was ever anticipated, for the indicators of the clinometers did not admit of a swing beyond 30 deg. There is, of course, the important question as to the difficulty of fitting bilge keels upon these larger battle-ships, which would admit of the vessels being subsequently docked. This cannot, however, be advanced as a valid reason for not fitting them, in some shape or form, if they are in reality a necessity,

as the obvious alternative is not to spoil the ships to suit the shape of the docks, but to alter the docks so as to suit the ships. Yet the shape of the docks does appear to have influenced the Admiralty in the design of these vessels, not only as regards the absence of bilge keels, but also as regards their under-water form. Alongside of the midship section of the Royal Sovereign we have engraved that of the Campania. The difference between the two is most remarkable. The Royal Sovereign possesses all that smooth roundness of bottom which was such a prominent feature of the Great Eastern, and which doubtless contributed largely to make her at sea one of the most uncomfortable rolling tubs that was ever launched; whilst the Campania possesses a box-like form and square angles that must present the greatest possible resistance to the influence of rolling. It is manifest, however, that the Campania could not enter a dock that was just shaped to receive the Royal Sovereign, even if it were long enough. Nevertheless, we cannot avoid a sneaking tenderness for the box-form midship section. It must be the very best to neutralize the inclination of the vessel to roll, and the flat bottom gives splendid machinery space and magazine room very low down.

Something must, however, be done to remedy this really grave evil of rolling. The eight magnificent battleships cannot be left in their present condition, for as it is they are a discredit to our navy. It is satisfactory to learn that experiments are about to be made with the Repulse, in the fitting of bilge keels. We shall await her trials, thus fitted, with considerable impatience. To the unprofessional eye it would almost appear that something of the nature of a telescopic sliding keel, or of a hinged lee-board, might be contrived, which could be withdrawn in dock or in smooth water; but there are, possibly, insurmountable difficulties in the application of alternatives of this nature. Bilge keels have, necessarily, to be made of immense strength, as the whole strain of the righting force comes upon them in action. We repeat, nevertheless, that a remedy will have to be found for the serious propensity which the Royal Sovereign class has exhibited.

THE CORRECT IDENTIFICATION OF DEEP SEA SOUNDINGS.

By Captain D. Wilson Barker, R. N. R., F. R. Met. Soc., F. R. G. S., etc.

[*First published in Science Gossip, April, 1892.*]

In the ordinary way it would appear that a rough description of the nature of a bottom from the specimen brought up in the sounding tube or snapper, would be an easy matter. But this I have found to be extremely erroneous in the hands of the majority of observers.

To take, for instance, such simple cases as one constantly sees marked on the charts where the bottom is recorded as crl. (coral); the uninitiated would at once associate this sounding with the calenterata, and would, in the majority of cases, be wrong; for the crl. noted is more frequently either fragments of calcereous seaweeds or of polyzoa, which in places cover the bottom of the sea over large areas and to great depths. Another case is that caused by constantly mistaking the larger foraminifera for sand-grains, the rubbing of a small piece of the sounding between the fingers making it appear sandy, though an ordinary pocket lens would at once show the difference. Cases such as the above might be multiplied considerably. It is almost unnecessary to point out what a loss it is to oceanography that such descriptions should be erroneously made, and in the majority of cases there would be no difficulty in giving a more correct description. It may be said that the soundings

can always be overhauled afterwards and the results given to the world; but this is only done in isolated cases and the results are not very accessible. Again, the descriptions recorded in the charts are generally taken from those noted when the sounding is taken, when observations as to color, scent, and stratification should also be noted. I would like to suggest that soundings taken with the ordinary tube sounders should be preserved in glass tubes closed at both ends by corks. The soundings being forced directly from the sounding-tubes into the glass tubes, their preservation is then much more perfect than in the ordinary way. A label affixed to the tube gives locality of sounding, notes as to color, scent, stratification and surface of sounding, etc.

THE HYDROPHONE.

The principal object of this simple apparatus is to give warning to a port or fleet of the approach of a torpedo-boat, even if the latter is totally submerged and therefore quite invisible. As described in the London *Times* it consists essentially of two parts, one submerged in the sea at a proper distance from the port or fleet to be warned, and at a depth sufficient to escape the surface agitation. This part may be described as an iron bell jar, which, on being plunged mouth downward into the water, retains a volume of air in the upper portion or bottom, where a copper box, protecting the sensitive organ of the apparatus, is fixed. The organ in question is merely a very delicate vibratory contact, which makes and breaks an electric circuit connecting the submerged bell with the indicator or second part of the hydrophone, situated on shore or on board one of the ships of the fleet. The contact is formed by a flat horizontal spring fixed at one end and loaded at the other by a heavy piece of brass, having on its upper surface a small platinum stud. A fine platinum needle kept upright by a vertical guide rests its lower end loosely on the platinum stud. The needle and the stud are connected in the electric circuit through the guide and spring, and when the needle dances on the stud the circuit is made and broken. An electric current from the ship or shore battery is always flowing through the circuit—that is to say, between the submerged bell and the indicator. Now, the propeller of a torpedo-boat or of a torpedo sets up vibrations in the water, and these, reaching the submerged bell, agitate the trembling contact, so that the needle dances on the stud and interrupts the current. The consequence is that the indicator begins to work and announces the submarine disturbance. This part of the hydrophone consists essentially of an electro magnet through which the current passes, with an armature free to oscillate when the current is rapidly made and broken—that is to say, when the current becomes intermittent. The motions of this armature can be seen by an observer if he chooses to watch, but actual observation is not required, for the indicator itself gives the alarm. This takes place when the swing of the armature carries it within the attraction of a magnetic contact piece fixed near it. The armature is then drawn to the contact piece and held fast there. The swinging armature and the contact piece are connected in the circuit of a local battery, and, when they meet, the current flows to ring an electric bell or light an electric lamp. The torpedo-boat thus announces its own arrival on the scene in spite of itself, and precautions can be taken against it.

The whole apparatus is beautifully worked out, and comparatively inexpensive. Moreover, it is sufficiently sensitive to announce the passage of steamers a mile distant from the bell. Obviously such an instrument might also be used for submarine signalling, for a ship, by stopping and starting her propeller, could send a message in the Morse Code, and the shore could respond by flashing the electric lamp. In the case of another ship the response might be made by her propeller.

THE RUSTING OF IRON AND STEEL.

[*Engineering.*]

The phenomena of chemical combination appear to be exceedingly complex. Not so very many years ago we were taught that a mixture of oxygen and hydrogen would combine to form water when an electric spark was passed through them. The matter appeared simple, was easily expressed in chemical formulæ, and illustrated by experiment. Now we have learnt that it is impossible to make such a mixture explode when it consists of perfectly pure and dry gases. When, however, the slightest trace of moisture is present, the combination takes place at once, thus illustrating the importance of those "next-to-nothings" which were so ably and so pleasantly discussed by Sir Frederick Bramwell in his address to the British Association. The oxidation of iron, though a more familiar phenomenon, is at least as complex as that of hydrogen. In spite of the proverb, this familiarity has been very far from breeding contempt, as its commercial importance has attracted very considerable attention to the subject, and though there is still much to be learnt, some few facts appear to be now established. In the first place, neither bright iron nor steel will rust in pure water or in pure air. The presence of carbonic acid, or some similar agent, seems necessary, although the final product may be destitute of carbon. Even when oxygen, moisture and carbonic acid are all present, rusting will not, it appears, take place unless the moisture condenses on the surface of the metal. When rusting does take place under ordinary circumstances, the first stage appears to be the formation of ferrous carbonate. This carbonate is then dissolved in carbonic acid water, to form ferrous bicarbonate, which latter is then decomposed in presence of air and moisture to form hydrated ferric oxide, magnetic oxide being formed as an intermediate product. This fact as to the formation of the magnetic oxide is curious, as the Bower-Barff process of protecting iron and steel consists in coating the metal with a firmly adherent layer of this very oxide.

Every one knows that when a bar of iron has commenced to rust, the corrosion proceeds apace. A polished bar will resist oxidation for a comparatively long time, even under somewhat unfavorable conditions, but once the rust has commenced to form, it does not take long for it to cover the whole of the bar. One reason for this may be the fact that the rust is electro-positive to the iron, but it is also partly attributable to the final product, the hydrated ferric oxide being only formed at the end of several intermediate stages of the oxidation, and to its hygroscopic properties, which favor the absorption of moisture from the air. In certain situations, other acids besides carbonic may take part in the corrosion of iron. The metal-work in bridges over railways is particularly exposed to fumes, and some engineers consider that in such cases no plates less than $\frac{3}{8}$ in. thick should be made use of, even in the case of the flooring.

The whole question of the rusting of iron and steel work has been discussed in considerable detail by Mr. Thomas Turner, Assoc. R. S. M., F. I. C., in a paper recently read before the South Staffordshire Institute of Iron and Steel Works Managers. It is now pretty generally acknowledged that, so far as ordinary exposure to the weather is concerned, iron is less liable to rust than steel. Unfortunately, however, this capacity for resisting rust seems to be greater in the common irons than in the best qualities, and has been attributed to the phosphorus contained in the former, which seems to have a protective action. When iron and steel are used in conjunction, there is no certainty which will be the more liable to rust. The potential difference of contact between the two is very small, and though in general wrought iron is found to be electro-positive to steel, there seem reasons for believing that this may not be so in all conditions.

Mr. W. Denny has instanced a case in which the steel shell plates of a vessel remained clean, whilst the iron stem plate and rudder forgings were

much corroded. The ballast tanks of ships are particularly exposed to rust. Bilge water is an exceptionally powerful corroding agent, and several engineers have suggested the use of iron plating in ships, in those parts exposed to bilge water, even when the body of the ship is of steel. In steam boilers it is claimed that there is little difference in the behavior of the two metals, and certainly steel boilers, when properly looked after, have been proved to have a long life. Plates thoroughly cleaned from scale are less liable to corrosion than when used just as they come from the rolls; and the Admiralty have accordingly adopted the practice of pickling the plates before being used. In a case of pitting, Mr. John found a particle of black oxide at the bottom of each pit. Experiment shows that this black oxide is strongly electro-positive to the plates.

Cast iron seems in general to last better in sea water than either wrought iron or steel. Trautwine, however, relates that the cast iron cannons of the Royal George and the Royal Edgar, after an immersion of 62 and 133 years respectively, had become quite soft, and were in some cases like plumbago. A very similar experience was noted with the cast iron sluice gates of the Caledonian canal. Much apparently depends on the quality of the iron. Trautwine recommends white, close-grained cast iron, whilst Mr. Turner quotes from a British Association report recommending gray iron.

The alloys of iron with nickel, cobalt and chromium appear less liable to rust than ordinary iron, whilst the presence of manganese appears to render the iron more sensitive to attack by corrosion.

FORGING BY HYDRAULIC PRESSURE.

At the meeting of the Institution of Civil Engineers on Tuesday, February 20, Mr. Alfred Giles, President, in the chair, the paper read was on "Forging by Hydraulic Pressure," by Mr. R. H. Tweddell, M. Inst. C. E.

The paper commenced by a brief history of the development of the hydraulic forging press since the year 1846, when the late Sir Charles Fox proposed the attachment of different tools for the working of hot or cold iron to the tables of the Brahmah press. The author then formulated the following conditions as necessary to be fulfilled to insure success in hydraulic forging:—First, the press must be so proportioned as to insure the utmost rigidity, any movement of the main columns, of course, interfering with the correctness of the work; secondly, the crane-power must be not only ample but so arranged that weights reaching to 100 tons could be manipulated by unskilled laborers; thirdly, the details of the construction of such parts as the valves and pumping-arrangements must be as perfect as possible. These conditions were discussed *seriatim*, and the author indicated the means by which they were met in the various types of forging-presses now made. Proceeding to particular makes of press, the paper gave descriptions of all those at present manufactured in England. This part of the paper concluded with a reference to the 22 cwt. steel ingot exhibited in the 1851 Exhibition by a Sheffield firm, the size of which was then considered quite exceptional; and by quoting Fairbairn's opinion of the value of the steam hammer in building up large masses of iron for the manufacture of large guns and marine engine shafts.

The second part of the paper was devoted to a comparison between the hydraulic forging press and the steam hammer. Starting with the axiom that noise and waste of energy were convertible terms, the author mentioned the points in which there could be no difference of opinion as to the superiority of the press. Its power was practically all exerted upon the forging, and not dissipated in shocks to the framing and foundations; it also occupied

much less head-room than a hammer, and consequently travelling cranes could be used, passing if necessary over the press. Further, not only could more work be turned out by a press than by a steam hammer in a given time; but it could work through a much greater range, for, while the effects of a "blow" shortened the life of any of the dies or tools used, it rendered impracticable the employment of numerous dies and moulds which were satisfactory under pressure. The art of forging large masses had made distinct advances since the introduction of hydraulic pressure; for it was formerly impracticable to forge the hollow marine shafts at present used, or to draw out gun tubes or hoops on the mandrel.

It was extremely difficult to draw the line where the tools described ceased to be forging-presses and became stamping and welding machines. Here there was more room for discussion as to the merits of forging-press *versus* steam-hammer, because many interesting questions arose as to the relative effect of a blow or a steady pressure when, for instance, stamping the iron-work used in wheel making. The author had preferred to confine himself to the hydraulic forging-press proper and to eliminate the mechanical treatment of metals by forging or pressing as a whole. Much thought had been expended in trying to calculate the size of hydraulic press that would be equal to a steam-hammer exerting a given force of blow, but in the opinion of the author the question was not worth pursuing, because until the amount of work done on the forging was equal and done in the same space of time no satisfactory comparison could be made. Owing to the action of the hydraulic press being constantly progressive the tool continued to free its way into the ingot until its resistance to alteration of form was equal to the pressure on the ram, or the latter was removed. In this it differed entirely from the action of a hammer which, having delivered one blow, did no more work until the following one. This constituted the essential difference between the two machines. The effect of the hammer was momentary, and there was not time for the pressure it gave to penetrate the metal, much less to alter its form to any extent at one blow; but in the hydraulic press the same rate of working per hour could be maintained, while the material was allowed every opportunity to flow in the required direction without injury. The effect of hydraulic pressure on forgings was to increase their homogeneity. The blow of a steam hammer was given with least effect when it was most required, that was, it could not get its full stroke until the forging was reduced in size, whereas the press gave its full power at any point in its stroke.

The paper was accompanied by an appendix giving a detailed account of each of the forms of forging-press alluded to in the text; by a note by Mr. Charles Davy, of Sheffield, comparing a press and a hammer doing nearly equivalent work; and by an account of some experiments by Mr. Coleman Sellers, of Philadelphia, on the number of hammer blows and the amount of hydraulic pressure required to deform similar test-pieces to the same extent.

THE BUFFINGTON-CROZIER DISAPPEARING GUN CARRIAGE.

On December 14, a Buffington-Crozier disappearing gun carriage mounting an 8-inch breech loading rifle was tested at the Sandy Hook Proving Ground with most remarkable results. It required only 12 minutes and 3 seconds for this carriage, worked by seven gunners, to fire ten shots. The wonderful aspect of this performance will be understood when it is explained that with every shot the rifle, weighing 33,000 pounds, was lifted from its loading position, and projected forward as though over a parapet. As the shot left the muzzle when fired the gun, recoiling without a jar, settled lightly upon its carriage bed ready for the next load.

The underlying principle of the mechanism is founded upon the geometric theories that if a right line move so that two of its points remain upon two other lines making an angle with each other the extremity or any other point of the moving line will describe an ellipse. The trunnions of the gun are mounted at the ends of two levers, which in turn are mounted at their centers on two hydraulic buffing cylinders, which are placed one on each side of the top of the carriage. The other ends of these levers carry the counterweight, a mass of metal weighing 37,000 pounds, placed in the centre of the carriage under the gun. When the gun is in the loading position, the hydraulic cylinders are thrown to the extreme rear end of the carriage, carrying with them the trunnions of the supporting levers and raising the counterweight, which is held in its elevated position by a system of pawls and ratchets. When the counterweight is released, it throws the rear ends of the gun-bearing levers forward and upward. The buffing cylinders are drawn forward over their stationary pistons to the front end of the carriage. At the same time the breech of the gun is carried up by steel arms, whose upper ends are pivoted to the gun and whose lower ends are pivoted to sliding blocks which move in circular grooves and which may be raised or lowered to give the desired elevation. When the discharge occurs the force of recoil throws back the upper ends of the levers, which, in turn, force the cylinders to the rear end of the carriage and raise the counterweight to its original position, where it is caught and held by the pawls and ratchets. Neither the gun nor any part of the carriage is exposed above the protecting parapet except for the instant of firing. The carriage allows a total vertical range of 20°, 15 of elevation and 5 of depression. It is calculated that two-thirds of the force of the recoil comes upon the hydraulic cylinders, the other third being used in raising the counterweight. It will be seen that the first movement of the gun at discharge is along a path nearly horizontal and that the final movement as it disappears behind the parapet is nearly vertical. In the test each shot weighed 400 pounds and was fired with a charge of 125 pounds of brown prismatic powder.

The carriage weighs 100,000 pounds. The steel castings were furnished by the Midvale Steel Company, of Philadelphia, and the work was done by the Southwark Foundry & Machine Company of the same place.

The record made during this test has no equal in the history of modern ordnance. It excels the rapid fire tests of 8-inch guns at Annapolis, where the rifles were mounted on stationary carriages of ordinary pattern, and where eight shots in 10 minutes and 20 seconds was the best work done. Further than this, it places at the disposal of the Government a disappearing gun carriage unequaled by anything of the kind employed abroad.

CANET TURRET ELECTRIC MOUNTINGS.

One design is applied to the cruisers Latouche, Tréville, and Pothuan by the Société des Forges et Chantiers de la Mediterranée, and also to one Danish coast defender. Electric mountings designed by Canet of a slightly different design have been fitted in the Captain Prat and also the Jauréguiberry.

The mounting proper consists of steel completely encircling the after part of the gun. In the forward part rest the trunnions, and it has bronze bearings to guide the piece in recoil. In the lower part are placed the brake cylinder and air recuperator for recovery after recoil. The trunnions rest in bearings in the steel frame on the turret platform. The brake is on the Canet central piston system, and is so fixed to the mounting frame as to check the tendency of the piece to rotate on its trunnions on recoil. The elevating gear is on the right side of the mounting and consists of a toothed pinion and sector with

endless screw, etc. The turret is constructed for central loading, and the weights are made to balance. The platform, made of sheet steel, carrying the mounting, rests partly on a circle of conical rollers and partly on a hydraulic press at the base of the central loading tube. On its external circumference is fixed the movable turret armor, with a sheet steel roof, in which is an armored hood for the head of the man pointing the gun. The central loading tube is fixed to the floor of the revolving turret, moving with it, the weight of turret and tube being partly borne by the ring of rollers, but chiefly by the press-head forming the pivot at the base. Below the revolving turret armor is a fixed ring. The structure on which the conical roller path rests is absolutely independent of the turret sides, and is protected by an armored circular wall. It differs from the disposition of the earlier turrets.

The working machinery includes the elevating and revolving gear, and the loading apparatus. The following features are to be noticed:—(1) The equilibrium of the turret on its own axis of rotation; (2) the carriage of the tube on a circle of rollers; (3) the support of the chief part of the weight on the hydraulic press. The training gear for rotation of turret includes a toothed wheel fixed on the central loading tube, with pin gear and endless screw, and electric motor. The gear for the motor is wholly contained in a closed cast cylinder fixed beneath the platform, connected with a lever worked by the man who points the gun.

The loading apparatus consists of an ammunition chain feed running up the central loading tube, and leading to the side of the carriage. The ascending feed chain with its charges is enclosed and protected by a brass cover, and projectiles and charges are brought by a hinged stage to the lower end of the feed chain, when the first projecting shelf which is brought past it catches it and carries it on up to a table on a bracket, which pivots on a vertical axis, bringing the ammunition to the breech of the gun. The feed can be worked either by electric motor or hand. Electric gear for direction is provided, and alternative hand gear.

The following advantages are claimed for the Canet quick-firing *matérial*:—(1) Great ease and speed of working; (2) uniformity of results in working, as may be seen by inspecting the records and curves traced; (3) great firing energy due to the great length and proportions of the piece; (4) strength of parts; (5) ease with which the piece may be mounted or dismounted and examined.

STEEL HOOPED CAST IRON MORTARS.

[*Engineer.*]

We are informed that some 12-in. mortars, made of cast iron bodies with steel hoops, are being made for the U. S. Government by the Builders' Iron Foundry, of Providence. With 80 lbs. of powder and a shell weighing 830 lbs., a muzzle velocity of 1200 ft. is calculated to be obtained, with a pressure of 12.5 tons per square inch. Vertical fire is the legitimate place to use inexpensive material, and if cast iron is ever to be used again it might be here. Most of us regard it as thoroughly played out, but by all means let the makers show what can be done.

SMALL-ARMS FOR THE SWEDISH GOVERNMENT.

The Swedish Government is contemplating the adoption of an improved rifle of the Mauser type, which has shown itself superior to others tested. It is proposed to make 10,000 every year for 12 years, and it has been arranged to have them made in Sweden under a royalty of 2.25 kr. per rifle, which

would make the cost of each rifle $12.50. For the first year, it will, however, be necessary to have them made abroad, pending necessary alterations at the Swedish small-arms factories. The price will, in this case, be higher, but it is proposed to buy only 5000 the first year.

ALUMINUM BOATS FOR THE NAVY.

The detailed plans of the Wellman Arctic expedition have attracted wide-spread attention. The use of aluminum for boats in particular has been noticed by scientists and officials. The Navy Department is awakening to the possible fact that boats of this material may be a valued addition to the equipment of the new men-of-war. In order that the department might be posted as to just what has been done with the metal, Naval Constructor Woodward was ordered to make a thorough test of the three Wellman boats and report as to the practicability of having aluminum life boats and launches for the new navy.

The first boat completed, which is eighteen feet long, four feet beam and two feet deep amidships, weighing 350 pounds, was thoroughly tested and was found to be more stable even than was expected. The boat was put into the water empty and a man tried to capsize it by sitting on the gunwale and hanging outside, but it was impossible to overturn it. It was then loaded with sand bags weighing 3333 pounds and seven men weighing 1128 pounds also got on board, making 4461 pounds in all. Even with this great load the boat was five and one-half inches out of water amidships.

The boat was then unloaded and the air-tight compartments were tested by capsizing the boat, but it was impossible to get it more than half full of water, as the compartments held it so high out of the water as to act on the principle of a self-bailer. The boat was then taken alongside of the wharf and filled with water until the gunwale was flush with the surface, and then a man got on either end over the air-tight compartments. Still the boat did not sink, and as soon as it was cast loose it heeled over and emptied out one-half the water and then righted itself. The air-tight compartments were subsequently tested by being filled with water, and when the doors were screwed down the boat was rolled over and the compartments were found to be perfectly tight.

Some very remarkable progress has been made lately by the Pittsburgh Reduction Company in obtaining aluminum material of high tensile strength. They are ready to place on the market sheet aluminum with a specific gravity not much above the ordinary aluminum sheet, with a tensile strength of 50,oco fo 60,000 pounds per square inch, an elastic limit of 35,000 pounds and a reduction of area of 15 to 20 per cent. They are in a position to furnish a metal which is as rigid under transverse tests as ordinary structural steel.

SIXTEEN-INCH GUNS FOR THE ARMY.

Preparations are under way for the manufacture of 16-inch guns at the Watervliet, N. Y., Arsenal gun shops. The guns will not be manufactured inside of 18 months, as it will require that time to make necessary arrangements and place the machinery in position. The lathes will be so constructed that 12, 14 and 16-inch guns can be manufactured. The plans for the gun-making machines were prepared by Anthony Victorin. Watervliet Arsenal, when the machinery is in operation, will be turning out the largest guns manufactured in this country. The cost of a single gun of the largest dimensions will be about $120,000.

JAPANESE ORDNANCE.

Six guns manufactured at the Japanese Government Arsenal at Osaka have been recently supplied to the Portuguese Government.

DESTRUCTION OF A BRAZILIAN TRANSPORT.

On Friday morning, February 23, the armed rebel transports Jupiter, Marte and Venus took up positions off Porto Madama and opened a bombardment upon the government batteries. The guns in the batteries responded quickly and quite a lively fire was exchanged. Suddenly there was a terrific roar heard above the booming of the guns, and it was at once conjectured that an explosion had occurred. At first it was thought that disaster had befallen the transport Marte.

Immediately the sound of the explosion was heard the men in the batteries and elsewhere along the shore saw a huge cloud column of reddish-brown smoke ascending, and spread out to wide dimensions as it arose. It was seen, as the smoke cleared away a little, that the explosion had occurred on the Venus.

The vessel had been torn in half, and almost immediately afterward the stern half of the wreck went to the bottom. The bow half was on fire, and in a few minutes the flames were raging furiously. This portion of the Venus floated for a half hour and then went down.

The Venus was commanded by Capt. Vasconcellos. He, with three officers and twenty-nine men, made up the complement of the vessel. Every soul on board of her was lost.

Some of the crew could be seen for a time on the forward part of the vessel as it drifted helplessly burning, and efforts were made to rescue them, but the boats that were dispatched on this work were slow in reaching the scene of the disaster, and by the time they arrived the men on the wreck were forced by the fire into the water. Apparently they could not swim, and they sank.

Many theories are current as to the cause of the disaster. The most probable of these is that a shot from the shore batteries struck the Venus amidships and plowed its way through hull and boilers. It is pretty certain that the magazine did not explode, for the smoke, as stated ashore, was of a reddish-brown color, whereas the smoke of powder is gray. At any rate, whatever the cause of the explosion, its force must have been terrific, as the vessel was blown into halves as though made of cardboard.

AUXILIARY WAR VESSELS.

The Secretary of the Navy has appointed a board of officers to consider the advisability of turning a number of the whale-back class of vessels into auxiliary warships. Many officers consider that the whale-back could be converted into a most formidable harbor defense vessel, and, on account of the little freeboard they present, and their deflective sides, which could be armored, valuable additions would be made to the Navy in an emergency, with but little cost and at short notice. Their high bows and cigar-shaped stems would render them dangerous ships as rams, and it is believed, further, they could be made of even less surface to present to an enemy, and with but little alteration practically turned into monitors, with the exception of the turrets.

TESTS OF CAMMELL'S HARVEYIZED PLATES.

Official reports in England indicate excellent results obtained with Cammell's steel plates with Harveyized faces. These show a power of resistance which is greatly in excess of what could formerly be given to a plate. For example, on August 31 last at Shoeburyness a plate 8 ft. by 6 ft. by 10½ in., weighing probably a little over nine tons, which had already been subjected to the usual attack of five 6-in. projectiles, was fired at twice with a 9.2-inch breech-loading gun discharging a Holtzer steel projectile weighing presumably 380 lbs. The first of the two had a striking velocity of 1808 foot-seconds, and an energy of 8614 foot-tons. The second had a striking velocity of 1948 foot-seconds, and an energy of 10,000 foot-tons. Consequently the calculated perforation of the latter on the English system is 19.5 in. of iron, or 15.6 in. of steel, and on Krupp's system 21.4 in. of iron, while the energy per ton of plate is 1111 foot-tons. The plate was broken by each round, and the point of the last got 18 in. past the back. But that the plate should have been almost uninjured by 5 6-in. projectiles, and afterwards have kept back two 9.2-in. Holtzer shot with the striking velocities above given, indicates greatly increased powers of resistance; although it seems that the Holtzer projectiles for the larger guns set up as well as breaking up, and do not appear to be so good either as the 6-in. Holtzer or as the larger Carpenter forged steel shot.

THE POLA ARMOR-PLATE COMPETITION.

[*Engineer.*]

We have been permitted to read the official report of a competitive trial of armor-plates which took place in October and November last. The plates competing were four nickel steel plates supplied by Dillingen, Vickers, Cammell and Witkowitz, as well as a Harveyized plate sent by Vickers, and a plate with a hardened face sent by Krupp, termed in the report a Harveyized plate, but this is probably a slip, as Krupp specially explains that it is not the Harvey process which be employs. The plates were 5.9 ft. by 7.87 ft. by 10.6 in. They were attacked by four rounds towards the corners from a 15-cm. (5.9 in.) gun, firing a steel projectile weighing 112.4 lbs., with a striking velocity of about 1980 ft. except one round fired at the Dillingen plate with 2070 ft. velocity, which was thought to be too severe for the gun, and it might be said for the plate also, seeing that it passed completely through. A fifth round was fired at the centre with a steel shot from a 24-cm. (9.4 in.) gun, the steel projectile weighing 474 lbs., with a striking velocity of 1417 foot-seconds. The 15-cm. projectiles were just a match for the plates, theoretically, the calculated perforation on the English system being 13.4 in. of iron or 10.8 in. of steel. The larger shot was an over match, having, theoretically, a perforation of 15.4 in. of iron or 12.3 in. of steel. The general result was that the Vickers Harveyized plate and the Witkowitz plate only were considered to have fulfilled the required condition of keeping out the smaller shot. The former was fractured by the larger shot, and the latter was not, nor did it let it perforate; so that while it may be wondered how this plate should beat those of the best makers known, it can be no wonder that the Austrians preferred their own plate. The Krupp plate had some flaw which caused it to break up in such a way as not to be a fair representative plate. It was the same kind of disappointment as occured at Ochta a year ago. It may be observed that the successful plate again was an untreated one. The report concludes in the following words: "The firing test is, however, significant in so far as it proves that a homogeneous nickel steel plate of corresponding

treatment is superior to the Harveyized plates, and this does away with the difficulties which would have arisen in case of the acceptance of Harvey plates, since with these latter plates a correction of the curvature is impossible after the carbonizing process, and every treatment on the outside is accompanied by the greatest difficulties." There is something in the common-sense sound of this paragraph that may commend itself, though incidentally we may notice that it is not the carbonizing process that affects the curvature, but the water process. There is trouble with very hard-faced plates. This is not in attaching them to the ship's side, as reported from America, seeing that the back is softer rather than harder than in untreated plates; the trouble is in attaching anything to the outside of the armor if necessary. It is a mistake, however, we think, to wonder or raise too serious an objection to such a difficulty, which may perhaps be met in more than one way. In spite of contradictory results occasionally obtained, the Harvey plates have obtained a series of such remarkable results that only those who are unacquainted with them would sit down and contentedly reject them at the present time.

SHIPS OF WAR OF THE UNITED STATES.

THE MONTGOMERY.

The new United States cruiser Montgomery accomplished her official speed trial off New London, Conn., on January 19, proving herself a speedier vessel than either of her sister ships, the Detroit and the Marblehead. The officially corrected speed made on the occasion has been reported by the trial board as 19.056 knots an hour, or rather more than 2 knots above that called for by her contract. This will give her builders, the Columbian Iron Works of Baltimore, Md., a premium of $200,000. The Montgomery's contract price was $612,500.

TORPEDO-BOATS IN THE UNITED STATES NAVY.

The Navy Department will soon have ready plans for the new 800-ton torpedo cruiser, which the Secretary proposes to construct if shipbuilders are willing to bid on her within the appropriation of $450,000, made by Congress three years ago. An attempt was made to build this boat at the time; but no bids were received on account of the great speed exacted and small chances of premium, and with every indication that the boat would cost more than the appropriation allowed. The Department has been at work again revising the old plans, and endeavoring to reduce the price of the craft. It is believed now that with modifications, which will not affect the value of the boat, that she can be built for the money Congress allowed. The new designs contemplate a boat of 800 tons displacement, 250 ft. in length, 27½ ft. beam, with two decks, part of the cabin on the spar-deck, conning tower, but with no turrets or armor. She will have as a battery several 6-in. rifles, a good secondary battery, and five torpedo tubes. She will be required to maintain a speed on her trial of 23 knots an hour, which would place her ahead of any vessel in the navy tried so far. Her engines will be powerful for a vessel of her size, and will be expected to develop 6000 indicated horse-power. The stroke of the piston will be 21 in., the revolutions of her screws wil be 315 per minute, and the steam will come from eight coil boilers, which will be kept going by a total grate surface of 30 square feet and a heating surface of 15,000 square feet.—*Army and Navy Journal.*

ENGLAND.

THE POWERFUL AND THE TERRIBLE.*

With reference to the two new cruisers, Powerful and Terrible, which are to be built by contract, orders have been given that the work of building the Powerful is to be begun at once, and by March 31 the sum of £57,544 will have been spent on her construction. Of this amount £42,500 is allowed for labor and materials in connection with her hull, fittings and equipment, whilst the remaining £13,750 will be laid out in making preliminary arrangements for the construction of her propelling and other machinery. The Terrible will not be begun until the next financial year, although it was at first intended that both ships should be laid down at the same time. The vessels will cost about £800,000 each, and will take at least three years to build. They will have a speed of at least 23 knots.

The Admiralty have decided to adopt in them the Belleville type of tubulous boiler. We understand 48 of these boilers are to be placed in the cruisers, the total weight in working condition being 950 tons. The horse-power to be developed is 25,000, and the speed of the vessels 23 knots. The power given by each ton of boiler is therefore over 26 indicated horse-power. Without assuming that the best results were got in the battleships of the Royal Sovereign class, it may be noted, by way of comparison, that with 12,000 indicated horse-power developed, the boilers in them gave about 20 indicated horse-power per ton, so that it is pretty evident that there is a considerable saving in weight. The Belleville boiler has not been tried in any British vessel yet, although now being fitted to the torpedo-gunboat Sharpshooter; but it has been very extensively adopted in French war-ships, with most satisfactory results. The engines in the cruisers are to be of the triple-expansion type, driving twin-screws. The vessels will be unusually long for cruisers, being about 500 ft., with a beam of 71 ft., and a displacement of about 14,000 tons. They will have great coal endurance, the coal bunkers being very large. These will assist in protecting the interior against the gun-fire of the enemy, while for a similar purpose a thick steel deck will be constructed at the load-line. There will be a large installation of quick-firing guns.

THE ST. GEORGE.

The St. George, the last of the nine first-class protected cruisers laid down under the Naval Defense Act, made an eight hours' official trial of her machinery with natural draught at Portsmouth on the 25th inst. She is of 7700 tons displacement, 360 feet long and 60 feet beam, and differs from the majority of her class in being sheathed with wood and copper. The designed load draught of the ship is 24 ft. 9 in., but her mean trial immersion was only 21 ft. 3½ in., or 19 ft. 4 in. forward and 23 ft. 3 in. aft. The average boiler pressure was 153.8 lbs., which was sustained by .09 in. of air-pressure, with a mean coal consumption of 1.62 lbs. per horse-power. The vacuum was 27.7 in., and the revolutions 100 per minute. Under these conditions the engines developed an indicated horse-power of 10,536, or over 500 beyond the contract. The average speed obtained was 20.2 knots. The trial was in every respect successful. It is not intended to subject the St. George to a trial under forced draught. The only vessels of the class which have been steamed for maximum power are the Grafton and the Edgar, of which the former indicated 13,484 and the latter 13,260 horse-power with closed stokeholds.

The St. George is fitted with triple-expansion twin engines, placed in separate engine-rooms, between which runs a middle line longitudinal bulkhead, a connection being made between them by water-tight doors. Each engine has three inverted vertical cylinders, of 40 in., 59 in., and 88 in. diameter respect-

* Details of foreign vessels are from *Engineer* or *Engineering*.

ively, all with a piston stroke of 51 in., and drives a three-bladed gun-metal screw propeller 16 ft. 1 in. in diameter, the crank shafts being in three pieces, and made interchangeable. The cylinders are each supported by a single cast iron column at the back, to which the guides are bolted, and by two cast steel columns of H section at the front. The high-pressure cylinders are fitted with piston valves, and the intermediate and low-pressure ones with ordinary double-ported flat slide valves all being actuated by ordinary eccentrics and twin-bar link motions; the reversing gear being of the all-round type, worked by independent engines. A gun-metal air-pump is fitted to each engine, and is driven by levers connected by links with the low-pressure cylinder crosshead. There are two main surface condensers of brass, having an aggregate tube cooling surface of 13,500 square feet, the circulating water being supplied by four centrifugal pumps driven by independent engines, and capable of delivering 1000 tons of water each per hour, the pumps being so arranged that each can supply the condenser of the adjoining engine, and all draw from the engine-room bilges in case of flooding or leakage. Steam from the main engines is supplied by four double-ended circular tubular boilers, each 16 ft. diameter and 18 ft. long, having thirty-two furnaces of 3 ft. 6 in. mean diameter of the Purves ribbed type. A three furnaced single-ended circular boiler is fitted for the supply of all the auxiliary machinery of the ship. The aggregate heating surface in all the boilers is 25,000 square feet, and the grate surface 855 square feet, and they are all designed for a working pressure of 155 lbs. per square inch. The coal bunker capacity of the ship, which includes the wing and upper bunkers, is 1200 tons. The armament of the St. George—which consists of two 9.2-in. breech-loading guns, ten 6-in., twelve 6-pounder, and five 3-pounder quick-firing guns, with seven Nordenfeldts, and four torpedo tubes—is disposed in a similar manner as in the other vessels of her class. With the completion of the St. George and her final passing into the reserve, all the additions of her class to the Navy provided for under the Naval Defense Act, 1889, will have been made.

THE SYBILLE.

Although two years have elapsed since the cruiser Sybille first arrived at Devonport from the works of her builders at Newcastle-on-Tyne, she has never yet, says the *Times*, been in a fit state to justify the officials in placing her in the fleet reserve as ready for sea, although in ordinary circumstances she should have been a fleet reserve ship three months after arriving in the port. Defective furnaces have been the cause of all the trouble. On her trials she obtained splendid results as far as horse-power and speed were concerned. The Admiralty were prepared to sanction almost any arrangement which would overcome the difficulty, and even the patching of cracked furnaces was permitted in order to save the contractors additional heavy expense. About six months ago, however, when further defects were discovered, the Admiralty gave the contractors to understand that the boilers would only be accepted in perfect condition. As a result, the whole of the interior work and fittings of the six furnaces has been renewed and other defects made good. To satisfy the Admiralty of the efficiency of the alterations, the Sybille was, on February 27, taken outside Plymouth Breakwater for a four hours' trial, but before she had been under way an hour the trial had to be abandoned owing to the heating of the eccentric strap of the port low-pressure engine and the destruction of the brass liner. The Sybille at once returned to Keyham, where the work of repair was taken in hand, and the trial has since been resumed with highly satisfactory results. With considerably less horse-power than at her eight hours' official trial she obtained a speed of 19.5 knots, as against 19.3 knots, and the machinery worked well throughout. After the trial the vessel returned to harbor, and the work of opening up her machinery for examination was at once taken in hand. The Admiralty accept the

machinery from the contractors, but with the understanding that the contractors are to guarantee the efficiency of the combustion chambers, as well as the furnaces, for a period of two years from the date of the first commissioning of the ship.

THE ANTELOPE.

The Antelope, gunboat, was taken outside Plymouth Breakwater for an eight hours' trial of her machinery. As this vessel is one of the Leda class, and fitted with the wet-bottomed locomotive type of boilers, it was never anticipated that she would prove a success. Her trial, however, was a surprise, for, in addition to exceeding the contracted horse-power with but ½ in. of air-pressure, she attained a mean speed of over 17 knots in a heavy sea, and with the wind recorded as five in force.

GUNNERY TRIALS OF THE REVENGE.

The Revenge completed her gunnery trials at Portsmouth on the 18th instant. As her smaller gun-fittings had been satisfactorily tested on the previous day, the day was devoted to firing from her 6-in. quick-firing guns and her barbette armament of four 67-tonners. The principal interest was centered on the after barbette, the right gun of which was experimentally mounted upon an improved slide. The original Elswick arrangement, as fitted to the other heavy guns, consists of a single recoil cylinder, having a large number of spring-loaded valves attached at the rear of the recoil press. This system was considered objectionable, on account of the liability of the valves to get out of order and to permit the gun and carriage to recoil without control, and it was deemed advisable to substitute a simpler and more trustworthy arrangement, with as few loaded valves as possible. It was decided to apply what is known as "the pull and push" method, requiring two cylinders, but a single-loaded valve, which can readily be examined and adjusted as circumstances demand. The system, however, is only new in its application, as it is merely a development of the original Vavasseur mountings as first adopted in the service. In the ships about to be built the "pull and push" system is to be still further simplified; instead of two there will be only one recoil cylinder per gun, and the presses will not be interfered with, the running in being performed by the force of the recoil, and the running out by means of springs. In the Revenge the running in of the gun on the slides is accomplished by the admission of water to one cylinder, and the running out by admitting it to the other. It may be mentioned that the principle of recoil presses fitted with valve keys is already extensively applied to small mountings. Three rounds were fired on the 18th instant from each gun in the after barbette, with reduced and full charges (that is to say, with 472½ lbs. and 630 lbs. of S. B. C. powder, carrying a projectile weighing 1250 lbs.), and an extra round from the right gun with an extreme elevation of 13½ deg., for the purpose of securing a diagram of pressures. The new mounting was perfectly successful, the only noticeable feature being the fact that the length of the recoil was practically the same under the reduced as with full charges. With three-quarter charges the recoil of the right gun was 4 ft. 7½ in., and that of the left gun 4 ft. 7 in. With full charges the recoils of the twin guns were substantially identical, that of the right gun being 4 ft. 8¼ in., and of the left 4ft. 7in., when fired simultaneously with 10 deg. of elevation. The difference is due to the application of different principles. In the hydraulic system the resistance behind the gun is already formed, and the length of the recoil varies with the charge, while under the bar system the resistance is generated by the recoil itself, and may be regarded as practically constant except as regards velocity. There were no misfires during the firing. A satisfactory trial was also made of Harris's feed-water filters, which had been supplied to the engines since the steam trial. The Revenge will, in April, be attached to the Channel Squadron in place of the Rodney, which is to relieve the Dreadnought in the Mediterranean.

BOOK NOTICES.

TEXT-BOOK OF ORDNANCE AND GUNNERY, COMPILED AND ARRANGED FOR THE USE OF CADETS AT THE U. S. NAVAL ACADEMY. By R. R. Ingersoll, Lieutenant Commander, U. S. Navy. Address U. S. Naval Institute, Annapolis, Md. Deutsch Lithographing and Printing Company, N. W. Corner German and Liberty Streets, Baltimore, Md., 1894. Price, bound in half leather, postage paid, $3.00.

This volume supplies such material for instruction as is not found in other text-books used in the course. The subjects covered are the following:—Chapter I. treats of the "Metals used in the Construction of Guns;" II. and III., "General Discussion," "Description and Manufacture of Naval Breech-Loading Guns;" IV., "The Slotted Screw Breech Mechanism, Gas Checks, Locks and Sights;" V., "Rapid-Firing Guns;" VI., "Machine Guns;" VII., "Naval Gun Carriages and Gun Mounts;" VIII., "Explosives;" IX., "Ammunition;" X., "The Stowage and Supply of Ammunition;" XI., "Armor and other Protection of Ships, Guns, Machinery, and Personnel;" XII., "Penetration of Projectiles;" XIII., "Torpedoes and Torpedo Defense;" XIV., "Naval Gunnery;" XV., "Field Fortification;" XVI., "Duties of Junior Officers of Divisions."

The volume was ready for issue except as to binding last fall, when the publishing house with all it contained was destroyed by fire. The book makes a very creditable appearance, and the well-known authority of the writer makes comment on the contents superfluous.

INTERIOR BALLISTICS. A TEXT BOOK FOR THE USE OF STUDENT OFFICERS AT THE U. S. ARTILLERY SCHOOL. By Captain Jas. M. Ingalls, First Artillery, U. S. Army, Instructor, Artillery School Press, Fort Monroe, Virginia, 1894.

In the summer of 1893, the author had leisure to work on the unfinished text book which had been partially completed and printed in 1889. Finding in the meantime so much of it that admitted of improvement, he decided to re-write nearly the entire work, as well as to complete it, according to the original plan, by the addition of the last two chapters. The chapters in succession are:

I., "Physical and Mechanical Properties of Gunpowder;" II., "Properties of Perfect Gases;" III., "Noble and Abel's Researches on Fired Gunpowder;" IV., "Formulas for Velocity and Pressure in the Bore of a Gun;" V., "Characteristics of Powder;" VI., "Non-Useful Energy;" VII., "Pressure on the Lands for Different Systems of Rifling."

Two tables are appended. Table I. gives for values up to $v = 50$, the total work that dry gunpowder is capable of performing in the bore of a gun, in foot-tons per lb. of powder burned (from Noble and Abel's Researches on Fired Gunpowder). Table II. contains the transcendentals used in the Velocity and Pressure Formulæ of Chapter IV., these transcendentals being calculated on the assumption that n, the ratio of the specific heats of powder gases, is $1\frac{1}{3}$, Noble and Abel's experiments indicating (at ordinary temperatures) a value of n of 1.32. The work, like all that falls from Captain Ingalls' pen, is well and carefully done.

Maxims for Training Remount Horses for Military Purposes. By J. T. Mason Blunt, Lieutenant, Fifth Cavalry, U. S. A. New York, D. Appleton & Co., 1894.

The author lays no claim to originality of idea or system, having simply compiled and condensed from various text and drill books in use in this and in other countries. He endeavors to place before officers acting as riding masters, and their assistants, the points more especially insisted on in the riding schools of other services. Of the *haute école*, he says nothing, the successful practice of that being a talent, not an art to be imparted by precept. The material of this little book undoubtedly holds a place of great importance in the literature of the practical cavalryman.

The Driggs-Schroeder System of Rapid-Fire Guns.

This little book, printed for private circulation and well illustrated, is complete in all that concerns the Driggs-Schroeder Ordnance.

The contents are: Essential Qualities of Rapid-Fire Guns; Characteristics of the Driggs-Schroeder System, and Analysis of the Qualities Inherent in it; Particulars of the Breech Mechanism; Directions for Dismounting and Assembling; Automatic Ejection; Rifling Calibers of Driggs-Schroeder Guns, Mounts, Fuzes; Drill and General Instructions; Range Tables.

Architecture Navale. Théorie du Navire, par J. Pollard et A. Dudebout, Ingénieurs de la Marine, Professors à l'École d'Application du Génie Maritime. Tome IV. Libraire Gauthier-Villars et Fils. Quai des Grands-Augustins, 55, A Paris. 13 francs.

The present volume ends the "Theory of the Ship." This remarkable work has been well received in France and by the shipbuilding world in general, and the last volume is worthy of its predecessors. It contains besides the study of resistance in oblique sailing, and theoretical and practical conditions of the turning motion, a copious revision of the various propellers in use in navies, and general considerations upon the vibrations of hulls, a subject of the highest interest at the present moment. Part IX. treats of the Ship's Dynamics in oblique horizontal rectilinear motion in a calm sea, resistance in oblique sailing; in chap. LVI., resistance of hulls of perfectly symmetrical lines, but unsymmetrical in relation to the direction of motion. Part X. deals with the Ship's Dynamics in horizontal curvilinear motion, Rudder-Gyrations, Resistance of the ship to the motion of uniform rotation round a vertical axis, Gyrations (Turning manœuvres) of steam-vsesels, etc. Part XI. treats of Propulsion by the Wind, Sails, Action of the Wind upon Sails. In Part XII. we have Mechanical Propulsion of the ship by means of an interior organ acting on the water. Part XIII., Vibrations of Hulls of Screw Ships, Causes and Periods of Vibrations, etc. J. L.

Interior Ballistics. By Lieut. J. H. Glennon, U. S. Navy. 8vo, 153 pages. Prices, postage paid, bound in half-leather $1.85, cloth $1.70, paper $1.50. Naval Institute, Annapolis, Md.

This is a remodelling and extension of a former article on "Velocities and Pressures in Guns" (Proceedings, U. S. Naval Institute, 1888), together with definitions and numerous practical examples. The titles of chapters are as follows:

I. Definitions.—Powder Chamber.—Firing-Test.
II. Properties of Gases.
III. Equilibrium in an Expanding Gas.
IV. Pressures in a Shell.
V. Quick-Powders in Guns.

VI. Laws of Combustion of Gunpowder.
VII. Muzzle Velocity and Maximum Pressure Formulæ.
VIII. Characteristics, Changes in Elements, Maximum Powders.
IX. Velocity and Pressure at any Point in the Bore of Gun.
X. Miscellaneous.
XI. Smokeless Powders.
XII. Rifling, Effects on Pressure.

TABLES.

Formulæ to be Used with Tables I. and II.
Table I. Velocities in Guns.
Table II. Pressures in Guns.
Table III. Density of Loading.
Table IV. Initial Air-Space.
Table V. Area of Cross Section of Bore.

The relation between the pressures on breech and projectile is given, and numerous other minor problems are solved. A chapter on smokeless powders with proper solution is included.

BIBLIOGRAPHIC NOTES.

AMERICAN.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

VOLUME LXVIII., No. 3, MARCH, 1894. Battleship Texas.

A description of the hull and armament, with three cuts.

Apparatus for Rapid Loading of Coal into Ships.

APRIL. Turret and Turret-Moving Machinery of the Battleship Texas.

An admirable article, fully illustrated. H. S. K.

ARMY AND NAVY JOURNAL.

VOLUME XXXI., No. 22, JANUARY 20, 1894. Tactical Instruction of Officers.

JANUARY 27. Naval Prospects.

FEBRUARY 10. The Hale Reorganization Bill. The Loss of the Kearsarge.

MARCH 3. New Arms for Army and Navy.

ARMY AND NAVY REGISTER.

VOLUME XV., No. 2, JANUARY 13, 1894. Retirements, U. S. Navy.

JANUARY 20. Personnel of the Navy.

FEBRUARY 10. A Navy Reorganization Bill. The Navy Personnel.

MARCH 10. The Carnegie Armor Contracts. Naval Personnel Bill. J. H. G.

CASSIERS' MAGAZINE.

VOLUME V., No. 29, MARCH, 1894. Present and Prospective Steam Engine Economy. Large Search-Light Projectors. Anti-Friction Materials (Carboid). H. S. K.

ELECTRICAL REVIEW.

VOLUME XXIII., No. 18, DECEMBER 20, 1893. An Electric Light-house for Fire Island. Eddy Motor on a Gatling Gun.

An electric motor to be applied to a Gatling gun has just been designed and manufactured by the Eddy Electric Manufacturing Company, of Windsor, Conn., which promises in part to revolutionize machine gun firing. The idea is not a new one, but this is said to be the first time that its application has been successful. The motor is in the breech of the gun and is protected from the enemy's shots by a metal case. It can be detached at any time and a crank substituted. By the motor 3000 shots a minute can be fired, while by the crank the gun will discharge only 1200. The motor is one horse-power and is very small, weighing only 50¼ pounds. The principal use to which the gun will be put will be on shipboard.

ENGINEERING NEWS AND AMERICAN RAILWAY JOURNAL.

VOLUME XXXI., No. 1, JANUARY 4, 1894. Engineering News: The Torpedo-Boat Ericsson. The Relative Powers of Gunpowder and Nitro-Glycerin. The New Navy of the United States.

JANUARY 11. Editorial Notes: The Standardized Screw Method of Measuring the Speed of Vessels. Recent Progress in the Manufacture of Steel Castings.

JANUARY 18. Engineering News: Failure of a Nickel Steel-Plate (not Harveyized) at Indian Head.

The Holtzer 8-inch projectile rebounded and was broken into pieces, but the plate (11¼ to 14 inches thick) was cracked through. A second shot wrecked the plate.

The modern Naval Status.

JANUARY 25. Editorial Notes:

A wave which struck the Normannia, compelled her to put back to New York for repairs, though about one-third of her journey was accomplished. The Normannia is 520 feet long, is of 10,000 tons burthen, and has engines of 16,000 horse-power. The hurricane-deck was swept, and the decks below flooded with from three to six feet of water.

FEBRUARY 8. The Raddatz Submarine Boat. Speed Premiums in Naval Contracts.

IRON AGE.

VOLUME LIII., No. 1, JANUARY 4, 1894. The Steam Trials of the British Torpedo-Vessel Speedy. The Ideal Engine Connected Direct to Dynamo. Winchester Model 1894 Reloading Tool. Progress in Naval Work Abroad.

JANUARY 11. Galvanized Iron for Stacks. The Buffington-Crozier Disappearing Gun-Carriage. The Hydrophone. A Proposed Torpedo-Ship. Iron Lighthouses.

JANUARY 18. Exhibit of the Creusot Works at the World's Fair. Aluminum: Its Properties and Its Uses.

JANUARY 25. An American Lighthouse. Aluminum: Its Properties and Its Uses (continued).

FEBRUARY 1. Recorder of Speed of Driven Shafts. The Colburn Dynamo.

FEBRUARY 8. Instability and Big Guns.

FEBRUARY 15. Hydraulic Testing Machines. Steel-Plate Rolling in Great Britain.

FEBRUARY 22. Basic Open-Hearth Process.

MARCH 1. Handling Steel Products by Electrical Power.

JOURNAL OF THE AMERICAN SOCIETY OF NAVAL ENGINEERS.

VOLUME VI., No. 1. FEBRUARY, 1894. The United States Triple-Screw Protected Cruiser Columbia. The Loss of the Victoria. The Contract Trial of the U. S. S. Marblehead. Comparison of Typical Ocean Steamers. Notes. Ships. Yachts.

JOURNAL OF THE FRANKLIN INSTITUTE.

VOLUME CXXXVII., No. 817, JANUARY, 1894. Subdivision of Steamships and Safety in Case of Injury; by Andrew Ham.

"Finally, no doors should be cut in bulkheads unless necessary to safety. Although this gives a lot of trouble to the engineers, it is necessary to safety."

JOURNAL OF THE MILITARY SERVICE INSTITUTION.

VOLUME XV., No. 67, JANUARY, 1894. The Nicaragua Canal (Prize Essay). Organization of the Armies of Europe. Municipal Neutrality Laws of the U. S. The Company Mess. The Evolution of Cavalry. Extended Order and Skirmish Firing. Comment and Criticism, Army Organization. Is the Three Battalion Organization Necessary for us? The Art of Subsisting Armies in War. Small-Arms Firing. Field Works in Military Operations. Reprints and Translations: 1. The Fundamental Principles Underlying the Battle Tactics of the Different Arms; 2. The Strategic Value of Canadian Railways; 3. Coast Artillery Practice; 4. Cavalry in Future War. Military Notes: The Watkin Depression Range Finder; Metal Shields for Infantry; Apparatus for Indirect Fire; Infantry Fire at Long Distances; Mitrailleuse in the Cavalry Division; New Patterns for Infantry Packs; Dismounted Fire-Action of Cavalry; Notes on Long Guns. Reviews and Exchanges. Index to the Literature of Explosives, Part II. Resistance of Ships and Screw Propulsion. Outposts, Patrols, Advanced Guards, Rear Guards. J. H. G.

MARCH. The Fixed Coast Defenses of the United States.

Taking as his text two articles that have appeared in the *Annual of the Office of Naval Intelligence*, advocating the transfer of the sea-coast de-

fenses to the Navy, Lieut.-Col. Hains writes an interesting paper defending the present system. In much of what he says he is in accord with naval men, whether they agree with his final conclusions or not; but his quoting the disappearing and lift mounts for heavy guns, and the use of mortars for sea-coast batteries as reasons why the Navy should not have control will scarcely add to the force of his general argument. He sums up by saying "Our Army is our defensive arm, our Navy should be the offensive one. Do not hamper the Navy with coast defenses, but give it freedom for offensive action. Even then its sphere of action may be limited, but if it cannot act offensively, it cannot act efficiently. For this reason, if for no other, our fixed coast defenses should not be transferred to the Navy."

Organization of the Armies of Europe. Rifle Practice in its Relation to Eye Strain. A General Review of Existing Artillery. The German Manœuvres. H. S. K.

JOURNAL OF THE UNITED STATES ARTILLERY.

VOLUME III., No. 1, JANUARY, 1894. The International Electrical Congress of 1893 and its Artillery Lessons. Siege Artillery. Vertical Fire, by Captain E. L. Zalinski, 5th Artillery, U. S. A. Formulas for Velocity and Pressure in the Bore of a Gun, by Captain James M. Ingalls, 1st Artillery, U. S. A. Artillery Target Practice, by 1st-Lieutenant G. N. Whistler, 5th Artillery, U. S. A. Field Artillery Fire. Fire Manœuvres of Artillery Masses and the Instruction to be Drawn Therefrom (translation). The Importance of Smokeless Powder in War (translation). Professional Notes: Adjuncts of Defense; Modern Field Artillery; Trial of Schneider's Nickel Steel Armor for Russia; Field Artillery on the Smokeless Battlefield; German Artillery Drill; The Latest Studies on the Detonation of Explosives,—the Explosive Wave. Book Notices. Department of Scientific and Military Information.

THE UNITED SERVICE.

VOLUME XI., No. 1, JANUARY, 1894. The Evolution of the Torpedo. Origin and Developments of Steam Navigation, by the late George H. Preble, Rear-Admiral, U. S. N. Among Our Contemporaries, by Edward Shippen, Med. Dir., U. S. N. Naval and Military Notes.

FEBRUARY. American Men for the American Navy, by F. M. Bennett, Passed-Asst. Engineer, U. S. N. Origin and Developments of Steam Navigation (continued). Among Our Contemporaries. Naval and Military Notes.

TRANSACTIONS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

VOLUME XIV., 1893. This volume of nearly fifteen hundred pages contains the records of the meetings at New York in December, 1892, and that at Chicago in August, 1893, the latter being the

*xxviii*th of the Society, and also the Sessions of Section B of Mechanical Engineering of the World's Columbian Congress of Engineering. Of the more than forty papers published, the following named are perhaps of most interest to naval people ;—

Limit of Propeller Efficiency as Dependent on the Surface Form of the Propeller; Tests of a Pump Receiving Suction Water under Pressure; A New Recording Pressure Gauge for Extremely Low Ranges of Pressure; Comparative Variation in Economy with Change of Load in Simple and Compound Engines, and Effect of Steam-Jackets on High-Speed Engines; Contribution to the Theory of the Steam Engine; Improvements in the Art of Cable-Making; An Evaporative Surface Condenser; Limitation of Engine Speed; A Coal Calorimeter; Technical Education in the United States; Compression as a Factor in Steam Engine Economy. In the paper on Technical Education, Professor Thurston gives a rather complete and very interesting history of the subject, as far as our own country is concerned, up to the present time, and concludes his memoir by urging the establishment of a grand National University at Washington. Not the least interesting part of the volume are the topical discussions. The whole is a very valuable publication.

H. S. K.

FOREIGN.

ANNALEN DER HYDROGRAPHIE UND MARITIMEN METEOROLOGIE.

XXI. Annual Series, 1893, Volume X. Notes on Jan Mayen and Spitzbergen. Harbors and Islands between Shanghai and Wenchan. From Rio Janeiro to São Francisco, Brazil. Extracts from the Journal of the Brig Atlantic. Remarks on the Harbors of Mexico, and on Corinto, and Estero Real, Nicaragua. Passages and Harbors on the West Coast of Mexico. Landmarks and Harbors on the Coast of Chile. Harbor of Tawhae, Naka-Hiva Islands, Marquesas Group. A Voyage on the Parana River. Bottle Post.

Meteorological Journals received at the German Observatory in September, 1893.

The Weather on the German Coast in September, 1893.

Volume XI. Meteorological and Hydrographical Conditions of the Steamer Route from Sydney to the Tonga and Samoan Islands. Chemical Examination of the Black Sea and the Sea of Azov in 1891 and 1892. Drift Ice in Southern Latitudes. German Bark Conrad Hinrich Ice-bound in the Okhotsk Sea. From Capetown to Loando. Voyages between São Thomé and Kameroon. From Buenos Ayres to Rio Janeiro. From Kobe to Yokohama. From Bangkok to Hong Kong. Voyage of the Bark Eilbek from Bordeaux to

Guaymas. From Callao to Pisagua. The Weather in Olehleh, North Sumatra, in January and February, 1891. Remarks out of the Log-book of the Steamer Erlangen.

Meteorological Journals received at the German Observatory during the month of October, 1893.

The Weather on the German Coast in October, 1893.

VOLUME XII. The Latest Progress in Scientific Discovery in the Antarctic Region. Condensed Report on the Magnetic Observations in Northern Germany in the past Twenty Years. Daily and Yearly Temperatures at Hamburg. Hurricanes in the North Atlantic between the 20th and 29th of August, 1893. Heavy Storms in Western Europe between November 16 and 20, 1893. Currents in the Straits of Messina. Minor Notes: Aldrabra Islands; Lota, Chile; Salaverry, Peru.

Meteorological Journals Received at the German Observatory in November, 1893.

The Weather on the German Coast in November, 1893.

ANNUAL SERIES, 1894, VOLUME I. Surface Temperatures at the Time of the Formation of Ice. The Wind on the SE. Coast of Australia. The General State of Wind in the Atlantic Ocean. (Supplement to the same Essay.) Review of the Weather in Germany during the Year 1893. From Yokohama to Kobe and Nagasaki. From Plymouth to Cadiz, Loando, Mouth of the Congo, Kameroon. Minor Notes: Meteors; Non-existence of the McCluer in the Southern Entrance to Djilolo Passage.

Meteorological Journals Received at the German Observatory in December, 1893.

The Weather on the German Coast in December, 1893.

H. O.

BOLETÍN DEL CENTRO NAVAL.

VOLUME XI., SEPTEMBER, 1893. A few Brief Historical Notes on Modern Naval Warfare. The Recent Naval Progress (from La Marine de France). The Cruiser 9 de Julio.

Report of Captain Don M. Rivadavia upon the construction, inspection and stores of the same.

J. L.

DEUTSCHE HEERES-ZEITUNG.

No. 90, NOVEMBER 8, 1894. Military Service in the Russian Army according to the Law of January 19, 1893. Belgium and Switzerland as Neutral Military Powers (continued). Naval and Military Notes.

NOVEMBER 12. The German Military Profession of To-Day. Belgium and Switzerland as Neutral Military Powers (concluded). Naval and Military Notes.

NOVEMBER 12. Moltke and Mühlbach.

A reply to a criticism of this publication.

Naval and Military Notes.

NOVEMBER 18. History of the Drum. The Loss of the Victoria from a Seaman's Standpoint.

The writer, Vice-Admiral Livonius, of the German Navy, reviews all the circumstances attending this catastrophe, and endeavors to account for Admiral Tryon's actions both before and after the collision.

NOVEMBER 25. The Defense of the French Frontier. The Loss of the Victoria from a Seaman's Standpoint (continued). Military and Naval Notes.

NOVEMBER 29. Ship Construction of Two Navies since 1889.

A comparison of the vessels built for the German and French Navies since that date.

Loss of the Victoria from a Seaman's Standpoint (continued). Naval and Military Notes.

DECEMBER 2. Loss of the Victoria from a Seaman's Standpoint (concluded).

The writer of these articles endeavors to account for the conduct and action of the Commander-in-Chief and his second in command. He rejects the suggestion that the former's action was due to temporary derangement of mind as inconsistent with his conduct throughout. He explains Admiral Tryon's conduct by assuming a lack of familiarity with this particular evolution,—that a man of his characteristics would not readily accept a suggestion from a subordinate, which would account for his change of purpose after he had agreed to increase the interval between the divisions. The writer attaches much blame to Admiral Markham, who, in his opinion, should have completed his signal to his Commander-in-Chief, and should have awaited a reply before answering the signal of evolution.

Ordnance Material of the European Field Artillery. Military and Naval Notes.

DECEMBER 6. A General Review of the Last Grand Manœuvres in France. Military and Naval Notes.

DECEMBER 9. The War of 1806 and 1807. Moltke and Bernardi on the Plan of War in 1866. Military and Naval Notes.

DECEMBER 13. A Criticism of the New German Fire Regulations. Military and Naval Notes.

DECEMBER 16. The French Reserve Officer. Military and Naval Notes.

DECEMBER 20. The First Troops Armed with Lances in the Army of Saxony. Military and Naval Notes.

DECEMBER 23. The Battle of Loigny-Pourpy on December 2, 1870. Reorganization of the Austrian Field Artillery. Military and Naval Notes.

DECEMBER 30. The Russian Frontier Guard. The Field Kitchen of Colonel Alexejiff, of the Russian Army. England's New Naval Programme. The Latest Torpedo-Boats.

A description of recent constructions of these vessels for the different European Powers.

Military and Naval Notes.

JANUARY 3, 1894. The Retreat of the 13th French Army Corps from Mezières to Paris, September, 1870. Military and Naval Notes.

JANUARY 6. The Retreat of the 13th French Army Corps from Mezières to Paris, September, 1870 (continued). Military and Naval Notes.

JANUARY 10. Loss of Vessels of War in 1893.

A review of the losses during the past year.

Military and Naval Notes.

JANUARY 13. Retreat of the 13th French Army Corps from Mezières to Paris, September, 1870 (continued). Military and Naval Notes.

JANUARY 17. Defense of the SE. Frontier of France. Retreat of the 13th French Army Corps from Mezières to Paris, September, 1870 (concluded). Military and Naval Notes.

JANUARY 20. Was it Necessary to Leave Metz in 1870? Military and Naval Notes.

JANUARY 24. The War on the Loire in 1870. The Russian Achotnikks, and Night Attack. Military and Naval Notes.

JANUARY 27. The War on the Loire in 1870 (continued). Balloon Service in the Russian Army. Military and Naval Notes.

JANUARY 31. Examination of the Tactics of the Future. War on the Loire in 1870 (continued). Military and Naval Notes.

FEBRUARY 3. New Vessels for the French Navy.

A review of the increase of the French fleet in the past year, the number and class of ships laid down, the progress of those building, and the number completed.

The War on the Loire in 1870 (continued).

FEBRUARY 7. Submarine Boats.

A brief review of the vessels of this class that have been built, and tried by the different countries.

War on the Loire in 1870 (continued). Military and Naval Notes.

FEBRUARY 10. Infantry Shields and Artillery. The War on the Loire in 1870 (continued). Military and Naval Notes.

FEBRUARY 14. The War on the Loire in 1870 (continued). Military and Naval Notes.

FEBRUARY 17. The Advantages of Smokeless Powder in Defending the Retreat of an Army. The War on the Loire in 1870 (continued). Military and Naval Notes.

FEBRUARY 21. The Accident on Board the Brandenburg.

An account of the accident on board this German man-of-war.

The War on the Loire in 1870 (continued). Military and Naval Notes.

FEBRUARY 24. The War on the Loire in 1870 (conclusion). 35 Years' Jubilee of the Battleship König Wilhelm. Military and Naval Notes.

FEBRUARY 28. Grand Manœuvres in France in 1893. Four Questions as to the Accident on Board the Brandenburg:

1. Why were not the doors leading to port engine compartment closed?
2. Why were fifty men in the engine rooms, when hardly one-half that number were necessary, and as the danger here is greater especially during trial runs?
3. Was the ship under forced draught, or had the forced draught just been put on when the accident occurred? If not, was it the intention to make the trial under forced draft?
4. What will be done with the machinery of the Brandenburg?

Military and Naval Notes. H. O.

ENGINEER.

VOLUME LXXVII., No. 1984, JANUARY 5, 1894. Carnot and Modern Heat, by Dr. Oliver Lodge, F. R. S. Editorial on 1894: Mechanical Engineering; War Material; Harbors and Waterways; Sanitary Engineering. Parliamentary Notes: H. M. S. Resolution.

JANUARY 12. Carnot and Modern Heat (continued). Water-Tube Boilers. The Safety of Compressed Gas Cylinders. Editorial: Iron and Steel in Shipbuilding; Aluminum Yachts; Improved Main Steam Pipes. Launches and Trial Trips.

JANUARY 19. Water-Tube Boilers, No. II. Carnot and Modern Heat (continued). Competitive Trial of Steel Armor at Texel. The Boughton Telephotos. Editorial: The Machinery of the U. S. Navy. Engines for the Poltava and Tri Sviatitelia. Torpedo-Boats in the United States Navy.

JANUARY 26. Carnot and Modern Heat (continued). Water-Tube Boilers, No. III. Hydraulic Propulsion. Editorial: The Effect of Hardening Steel upon its Electrical Resistance. Trial of H. M. S. St. George. Continuous Current Pump. Ogle's Protractor. Some Scientific Uses of Liquid Air. The Temperature of Combustion of Explosive Gaseous Mixtures.

FEBRUARY 2. Rolling of Battleships of the Royal Sovereign Class. Carnot and Modern Heat (continued). Water-Tube Boilers, No. IV. Fly-Wheel Dynamo. Editorial: Engineers for the Navy; The Cordite Case; The Texel Armor Competition. Hydraulic Testing Machine. Phœnix Iron Works, Phœnixville, Pa. H. M. S. St. George. Research Committee on Marine Engine Trials.

FEBRUARY 9. Water-Tube Boilers, No. V. Carnot and Modern Heat (continued). Cânet Electric Turret Gun Mountings. Torpedo-Boat Destroyers for Foreign Navies. What a Tidal Wave Did. Research Committee on Marine Engine Trials (continued). Editorial: Marine Engine Trials; The Cordite Case; The Pola Armor-Plate Competition; Tests of Cammell's Harveyized Plates. French Shipbuilding in 1894. Launches and Trial Trips.

FEBRUARY 16. Carnot and Modern Heat (continued). Water-Tube Boilers, No. VI. The Japanese Cruiser Yoshino. Photo-Mechanical Printing in Colors. Water-Tube Marine Boilers. Editorial: Admiralty Orders and Clyde Docking Facilities; The Close of the Cordite Case.

In the opinion of the Court, the wording of the ballistite specification pointed plainly to the use of soluble nitro-cellulose, and a forced reading was necessary to make it include the employment of insoluble nitro-cellulose. A reason for this preference, distinct from the greater ease with which nitro-glycerin could be gelatinized with soluble nitro-cellulose, was to be found in the state of knowledge at the date of the specification, which was such that insoluble nitro-cellulose seemed to require the adoption of methods of incorporation more inconvenient and dangerous than those which sufficed for soluble nitro-cellulose. With this knowledge in mind, the failure of Mr. Nobel to claim the use of insoluble nitro-cellulose becomes intelligible, as if shown to be impracticable it would invalidate the patent. The difficulty could obviously have been met by obtaining a second patent, but wisdom posterior to the event is of a somewhat cheap order, and no inventor, however far-seeing, can be expected to provide for every outcome of a prolific idea.

The lessons inculcated in this most costly exposition are few, brief, and weighty. The most important scientifically is that the chemistry of nitro-cellulose is in need of extension and revision. That of greatest technical moment is that the arbitrary division of nitro-cellulose into soluble and insoluble varieties is of vanishing significance unless the solvent be accurately specified.

Trial of McPhail and Simpson's Superheater.

FEBRUARY 23. Carnot and Modern Heat (continued). Editorial: The Catastrophe on the Brandenburg; Shipbuilding 13,000 Feet Above Sea-Level.

(Reconstruction of a 500-ton steamer on the banks of Lake Titicaca).

Engineering Works on the Thames: No. 1.—Messrs. John I. Thornycroft and Co. Thackeray's Audible Direction Indicator.

The primary object of this apparatus is to provide a simple automatic check on the working of marine and other engines, and audibly indicate

whether, and when, orders given to the engine-room are correctly carried out.

This direction indicator affords assurance to the navigating officer that his orders to the engineer have been understood and complied with. Should the engineer inadvertently misinterpret the order sent, both officers are instantly warned, as the bells continue to ring until the order has been correctly carried out. Thus the officer in command is informed whether the engines are being worked as he wishes, and makes his calculations with assurance and certainty. The engineer knows that he has carried out the orders sent to him. Any error or delay below is at once apparent to those on deck, and the ordinary reply gear of the engine-room telegraph is rendered unnecessary, as the engines themselves show by stopping the bells ringing that the order has not only been seen but actually carried out.

If, for any reason, the engineer shifts the reversing gear before a fresh order is given from the bridge, his doing so causes the bells on the bridge and in the engine-room to commence ringing, and thus the attention of the officer on the bridge is at once aroused.

Being an audible signal it is especially valuable at night, or during intricate navigation and sudden emergency, possible groundings or collision, when the officer's attention is taken up in looking ahead and giving other orders.

With the exception of the small contact maker fixed to the transmitter of the engine-room telegraph, this apparatus is quite distinct. It affords a separate and additional means of communication between the bridge and the engine-room; so that when the ordinary gear of the telegraph gets out of order, and the dial in the engine-room fails to correspond or work with the dial on the bridge, if the engineer moves his reversing gear until he stops the bells of this direction indicator ringing he will have carried out the order from the bridge.

Thackeray's audible direction indicator can be readily fitted to any ordinary telegraph and reversing gear, without interfering with existing arrangements, and without causing extra exertion, attention, or trouble in manipulation or keeping in order.

Forging by Hydraulic Pressure. Launches and Trial Trips.

MARCH 2. The Utilization of the Nile. Morison's Evaporator. Editorial: Circulation in Water-Tube Boilers; Clyde Ship Building; Our Merchant Steam Shipping. Lyons' Apparatus for Purifying Feed-Water. Electric Indicator of Ship's Position in a Harbor. Launches and Trial Trips.

MARCH 9. A Run with "Petrolea."

The use of liquid fuel is asserted to cause no excessive wear of the fire-box; indeed it is stated that, owing to the smaller draught required, the blast-pipe orifice can be enlarged 50 or 60 per cent., thus reducing the wear and tear alike of fire-box, tubes, smoke-box, and chimney, preventing emission of sparks and ashes, and by diminishing back-pressure, promoting economical working. As already pointed out, the steam pressure can be regulated with great ease and nicety by varying the supply of liquid fuel, so that in case of exceptionally heavy roads, high winds, severe gradients, etc., an increased supply of steam can be quickly generated; while, in the event of a sudden check, the generation of steam can be promptly lessened.

Coupled Horizontal Compound Tandem Jet Condensing Pumping Engines. Harbors and Waterways. The Utilization of the Nile. Editorial: Steel Furnaces; Paris a Seaport. Forrest's Silver Bronze Rod Packing. Hydro-Electric Installation, Antwerp. Launches and Trial Trips.

ENGINEERING.

VOLUME LVII., No. 1462, JANUARY 5, 1894. Shipbuilding and Marine Engineering in 1893. H. M. S. Resolution. U. S. Commerce Destroyer Columbia. Launches and Trial Trips.

JNNUARY 12. Shipbuilding and Marine Engineering in 1893 (continued). Foreign Warships Launched in 1893. The British Cruisers Powerful and Terrible. Ordnance Trials of H. M. S. Centurion. Economical Speed of Steamships. Launches and Trial Trips.

JANUARY 19. The British Torpedo-Boat Destroyer Havock. Launches and Trial Trips. Technical Education. The Surplus of Shipping. American Universities and Colleges. Captain Wiggins' Expedition to the River Yenesei, Siberia.

JANUARY 26. The Manchester Ship Canal.

A complete description with illustrations, occupying 85 pages of *Engineering*.

Engines of H. M. SS. Resolution and Revenge. H. M. S. St. George. Launches and Trial Trips. Gunnery Trials of the Revenge. The Gases Enclosed in Coal.

FEBRUARY 2. The Silvertown Water Level Indicator. The Position of Marine Engineers. Fact and Fiction in Boiler Explosions. Mr. Preece on Electric Progress in America. Launches and Trial Trips.

FEBRUARY 9. The Rusting of Iron and Steel. Marine Engine Trials.

Abstract of results of experiments on six steamers and conclusions drawn therefrom in regard to the efficiency of marine boilers and engines, by Professor T. Hudson Beare, F. R. S. E., of London.

FEBRUARY 16. The Johns Hopkins University, Baltimore. The Hoboken Ferry Steamer Netherlands. Editorial: Storage Reservoirs on the Nile. Electric Lighting in the City of London. Notes: Torpedo-Boat Designs; Expansion Strains in Boilers. Raising Steam by Towns' Refuse. A Yachting Exhibition. The Breuer-Schumacher 1200-Ton Hydraulic Forging-Press. McPhail and Simpson's Steam Generator and Superheater. Heating Boiler Explosion at the Guildhall.

FEBRUARY 23. The University of Chicago. The Belgian Government Mail Steamer Marie Henriette. Launches and Trial Trips.

12-Inch Spring Return Mortar Carriage. 160-Ton Crane at H. M. Dockyard, Chatham. Editorial: Admiralty Practice; Why We Need a Navy. The Leeds Circulating Boiler Explosion. Marine Engine Trials (concluded).

MARCH 2. An American Cruiser on Service.

Comment on the chase of the Itata by the Charleston, using the data furnished by Mr. I. N. Hollis.

Armstrong Quick-Firing Guns. Breakwaters and Sea-Defenses in Italy. Morison's Evaporator. H. M. S. Hornet. Submarine Telegraphic Enterprise. Recent Breakwaters and Sea-Defenses in Italy (continued). Launches and Trial Trips.

MARCH 9. Armstrong Quick-Firing Guns (continued). Electric Launches. The Belgian Government Mail Steamer Marie Henriette. Launches and Trial Trips. The Improvement of the River Clyde. Testing the Magnetic Qualities of Iron. Notes: Superheated Steam in Small Motors; The Working of the Boiler Explosion Acts; Shipwreck List; the Largest Balloon in the World. H. M. S. Sybille. Recent Breakwaters and Sea-Defenses in Italy (concluded).

JOURNAL OF THE ROYAL UNITED SERVICE INSTITUTION.

OCCASIONAL PAPERS.

VOLUME XXXVIII., No. 191, JANUARY 15, 1894. The Action of Cavalry and Horse Artillery Illustrated by Modern Battles. The Rise, Decay and Revival of the Prussian Cavalry. The Effect of the Lee-Metford Bullet on the Bones of Horses.

FOREIGN SECTION.

The Three Days' Naval Action in the Dardanelles on the 17th, 18th and 19th of July, 1657.

Translated from the *Marine Rundshau.*

The Dashiell Gun. Manœuvres: their Planning and Execution. Naval and Military Notes.

FEBRUARY 15. The Telephotos. Origin and History of Admiralty Badges. Magazine Rifle Trials in the United States. The Russian Navy.

Translated from *La Vie Contemporaine.*

Notes on the English Naval Manœuvres of 1893.

Translated from the *Rivista Marittima* of January, 1894.

Naval and Military Notes.

MARCH 15. The Ram, in Action and in Accident. Electric Light Projectors for Coast Defense. Naval and Military Notes.

J. H. G.

MILITÄR WOCHENBLATT.

No. 98, NOVEMBER 8, 1893. The French Manœuvres, 1893 (concluded).

NOVEMBER 11. Review of the Imperial Manœuvres in Alsace and Lorraine (concluded). The New Proving Ground Maipous Lafitte, near Paris. Redistribution of the Italian Navy.

NOVEMBER 15. Infantry in the Manœuvres of 1893.

NOVEMBER 18. Extension of the Front during the Franco-German War, 1870-1871. New Instructions for Duty on the General Staff of the French Army. French Reserve Regiments.

NOVEMBER 22. Extension of the Front during the Franco-German War, 1870-71 (continued). Grand Cavalry Manœuvres of this Year, in the Military District of Warsaw.

NOVEMBER 25. Extension of the Front during the Franco-German War, 1870-71 (continued). Loss of H. M. S. Victoria.

A review of the decision of the English Admiralty in regard to it, and the lessons to be learned from it.

NOVEMBER 29. Extension of the Front during the Franco-German War, 1870-71 (continued). Suggestions on the Use of Troops in Manœuvres. Garrison Exercises for French Reserve Officers.

DECEMBER 2. Battle of Loigny-Pourpy. Extension of the Front during the Franco-German War, 1870-71 (continued).

DECEMBER 6. Battle of Loigny-Pourpy (concluded). Extension of the Front during the Franco-German War, 1870-71 (continued).

DECEMBER 9. Extension of the Front during the Franco-German War, 1870-71 (concluded). Regrouping of the French Fortifications.

DECEMBER 16. Remarks on Cavalry Manœuvres. The War of 1806 and 1807.

DECEMBER 20. Remarks on Cavalry Manœuvres (concluded). Battle Exercise in the Camp of Krassnoe-Selo. The Military Geographical Institution of Austro-Hungary. The Spanish Armored Cruiser Infanta Maria Teresa.

A brief description of the vessel.

DECEMBER 23. The Development of the Field Artillery. General Mercier of the French Army.

JANUARY 3, 1894. A Criticism of Prince Frederick Carl. Charleston, 1860-1865. The Age Limit in the French Army.

JANUARY 6. Criticism of Prince Frederick Carl (conclusion). The Siege Artillery of France. Reorganization of the Swiss Army.

JANUARY 10. The Fortifications and Defenses of Switzerland. The Infantry Attack. History of the Uniform of the Army of Frederick William III.

JANUARY 13. The Fortifications and Defenses of Switzerland (concluded). History of the Uniform of Frederick William III. The Infantry Attack (continued). French Reserve Exercises in 1894.

JANUARY 17. Sanitary Regulations of the German Navy. Exercises of the 2d and 6th Divisions of Cavalry of the French Army.

JANUARY 20. Criticism of Napoleon I. The Infantry Attack (continued).

JANUARY 24. The Shortest Route to Constantinople. The Infantry Attack (concluded).

JANUARY 31. German Infantry Tactics of To-day. Foreign Opinions of High Velocities and Rapid-Fire for Field Artillery. Grand Manœuvres of the French Army for 1894.

FEBRUARY 3. German Infantry Tactics of To-day (continued).

FEBRUARY 7. German Infantry Tactics of To-day (continued). Foreign Opinions on High Explosive and Rapid-Fire for Field Artillery (continued).

FEBRUARY 10. A Retrospect of the Training of Infantry. The New Italian Minister of War and his Programme. Defeat of the Dervishes by the Italian Colonial Troops at Agordat. The Field Artillery of the U. S.

A description of the armament of our light artillery.

FEBRUARY 14. The Armored Defenses of Metz. Correspondence from Austro-Hungary.

FEBRUARY 17. Russian Railroads. Fire Regulations for the Italian Field Artillery. The Post-Graduate Course Established at the French War School, for 1894.

FEBRUARY 21. Communicating Commands to Infantry. Adjutants and Orderlies. The Battle on the Bann Kandi, Congo. Cadre. Exercises of the French Army for 1894.

FEBRUARY 24. Occurrences at Mellila on October 2, 1893. To the War on the Loire in the Fall of 1870. Smokeless Powder.

A brief review of the recent tests of different smokeless powders in the U. S. and other countries.

FEBRUARY 28. To the War on the Loire in the Fall of 1870 (continued). Reorganization of the Field Artillery of Austro-Hungary. Sanitary Condition of the Garrison at Cassel, Germany. To the Battle of Agordat.

SUPPLEMENT TO MILITÄR-WOCHENBLATT.

VOLUME XI., 1893. Charleston, 1860-1865.

VOLUMES I. and II., 1894. Self-Reliance of Subordinate Leaders in War. Contributions to the History of Napoleon I.

VOLUME 3. The European System of Napoleon I. Suicide in the Prussian Army. H. O.

MITTHEILUNGEN AUS DEM GEBIETE DES SEEWESENS.

VOLUME XXI., No. 11. English Fleet Manœuvres of 1893. French Fleet Manœuvres of 1893. Forcible Entrance of the Menam River by the French War-Ships Inconstante and Comète. Submarine Boats. The Effect of Changes in the Screw on the Speed of Vessels. The Fortifications of the Harbor Spezzia, Italy. Semaphore Signals on the Coast of Italy. The Cruiser Minneapolis. French Patrol-Boats (Chaloupes Cannonières) for the Upper Mekong River. French Armored Cruiser D'Entrecasteaux. French Torpedo-Cruiser Lansquenet. Accident on Board a French Torpedo-Boat. Notes on the English Navy. H. M. S. Devastation. Speed Trial of the English Torpedo-Catcher Renard. Notes on the Turkish Navy. New Cruiser for the Chilian Navy,—the Blanco Encalada, building at the Elswick Works. Speed Trial of the Spanish Cruiser Infanta Maria Teresa. Loss of the Russian Monitor Rusalka, and the Haytien Despatch Boat Alexandri Pétion. Trial of Armor Plates of the Russian Ship Tri Svjatitelja. Cost of Harvey Armor-Plate. Rearrangement of the German Coast into Districts. Effect of the Canal Between the North and Baltic Seas. Raising a Vessel by Means of Air-Bags.

No. 12. Italian Fleet Manœuvres of 1893. The Development of the Trans-Atlantic Steamer. Rigging of a Modern Sailing Ship. Torpedo-Boat of Large Displacement. French Naval Budget for 1894. The French Naval Building Programme for 1894.

VOLUME XXII., No. 1. Comparative Trials of Armor-Plates in Italy in November, 1894. Coal Consumption on Ships of War. The British Admiralty's Approval of the Findings of the Victoria Court-Martial. Three Latest Expeditions to the North Pole. The Maxim-Nordenfelt Guns. American Submarine Boats. Raising of a Sunken Steamer. Distribution of the French Torpedo-Boats for the Defense of the Coast. Firing at the Model of a Torpedo-Boat Moving at High Speed. English Torpedo-Boat Destroyer of the Havock Class. English Torpedo Supply Vessel Vulcan. Spanish Cruiser Infanta Maria Teresa. New Gunboats of the U. S. Navy. Preliminary Trial of the Italian Battleship Re Umberto. Italy's Submarine Cables. The Naval Budget of Holland for 1894. Coaling at Sea. Painting of Vessels of Different Naval Powers. Accidents during the British Naval Manœuvres of 1892. Enlargement of the Harbor of Fiume.

No. 2. Subsidizing Merchant Vessels. Report of Mr. W. H. White on the Loss of the Victoria. The Aluminium Yacht Vendenesse. The Manchester Ship Canal. A New Range Finder. A Battle on the Rio de la Plata. H. M. Torpedo-Boat Speedy. English Torpedo-Boats. Engines of the English Torpedo-Boat Destroyers Daring and Decoy. Foundering of H. M. S. Rodney's Torpedo-Boat in Gibraltar Bay. Speed Trials of H. M. Battleships Centurion, Barfleur, Revenge and Royal Oak. French Torpedo Trials. The Cruiser Columbia. Removing a Wreck in the Atlantic. The Bullivant Torpedo-Net.

No. 3. Bizerta. Diagram to Determine the Radius of Action of Ships-of-War. Reconstruction and Speed Trial of the Russian Ship Tegetthoff. Trials of Vessels' Running Lights in Holland. U. S. Navy. Brief Review of the Most Important Improvements and Changes in Guns and Small-Arms during 1893. On the Seaworthiness of H. M. S. Resolution. Stability of the French Battleship Magenta. Stability of U. S. Gunboat Machias. Speed Trial of the Italian Torpedo Cruiser Aretusa. Trial of the Howell Torpedo. Trial of the Sims-Edison Torpedo. Russian Naval Budget for 1894. Pierret's Compensation for Chronometers. French Torpedo-Boat Lansquenet. The New Admiralty at St. Petersburg. H. O.

LE MONITEUR DE LA FLOTTE.

No. 49, December 9, 1893.

A curious fact is related in this number which demonstrates the vagaries of torpedoes. Two torpedo-boats, the Téméraire and Mousquetaire were out for torpedo practice. Through some unaccountable cause, the torpedo fired from the Téméraire ran directly against the Mousquetaire, striking the latter amidships where the coal bunkers were situated. Prompt help alone from the Hoche prevented the boat from sinking.

December 16. The State of the New Construction.

New ships that will be put in commission in 1894.

Aluminium in Shipbuilding.

December 23. Mishaps to Torpedo-Boats.

December 30. The Navy in 1893.

Doings and happenings.

January 6, 1894. The Britannia and the Borda. Accidents in the British Fleet.

January 13. Germany and Colonial Policy.

January 20. Disappearing Turrets. Sea Derelicts. Floating Wreckage.

January 27. The Extra-Parliamentary Naval Board. Floating Derelicts.

FEBRUARY 3. Cruisers *versus* Battleships. The French and English Navy Budgets. The Navy in Parliament. The Extra-Parliamentary Naval Board.

FEBRUARY 10. Cruisers *versus* Battleships (2d Article).

FEBRUARY 17. The Fleets of the World at the End of 1893. French Coast Defenses. J. L.

PROCEEDINGS OF THE ROYAL ARTILLERY INSTITUTION.

VOLUME XXI., No. 1, JANUARY, 1894. A Method of Evaluating Corrections in the Case of Quick Targets, by Lieut-Colonel J. R. J. Jocelyn, R. A. German Smokeless Powder.

A new powder will be introduced, the present having many defects.

Trial of the New Smokeless Powder, Apirite.

Apirite, which possesses many valuable qualities for use with rifles of small calibre, was discovered quite recently in Stockholm. On competitive trial of ten rounds of nitro-powder, fifteen of ordinary Swedish powder and fifteen of apirite, the barrel was heated least by the apirite. The barrel after 800 rounds was left uncleaned, and at the end of eight days was as clean as if just prepared for firing.

FEBRUARY. Note on the Correction of Artillery Fire.

J. H. G.

REVISTA TECNOLÓGICO-INDUSTRIAL.

NOVEMBER AND DECEMBER, 1893. Chronicles of the Association.

A memoir read by the Secretary in the General Session, October 21.

Resistance of Materials.

A study on the trials of iron and steel. Lecture delivered by M. E. Cornut before the Congress of Applied Mechanics.

Important Electrical Installation.

REVUE DU CERCLE MILITAIRE.

No. 50, DECEMBER 10, 1893. The Mizon Mission (ended). The New German Regulations in Regard to Field Fortifications (ended). The Problem of Mounted Infantry Solved by the Use of the Bicycle.

DECEMBER 17. Spain in Morocco; Mobilization of the Spanish Army The Problem of Mounted Infantry Solved by the Use of the Bicycle (continued).

DECEMBER 24. The Maxim Machine Gun and the Swiss Cavalry. The Problem of Mounted Infantry Solved by the Use of the Bicycle.

JANUARY 7, 1894. Souvenirs of the Campaign of Tonkin (map). The New Fire Regulations of the German Infantry.

JANUARY 14. The Infantry and Cavalry Practice Schools in the Portuguese Army. The New Fire Regulations of the German Infantry (continued). Souvenirs of the Tonkin Expedition.

JANUARY 28. Use of the Algerian Sharpshooters in Case of a European War. The New Fire Regulations of the German Infantry (ended).

FEBRUARY 4. Provisioning of Troops in Time of War.

FEBRUARY 11. Our Military Operations in the Soudan (map). The Flying Machine of Prof. Wellner.

REVUE MARITIME ET COLONIALE.

VOLUME CXIX., DECEMBER, 1893. Notes on a Scheme of Steaming-Power Curves of Vessels (with diagram of steaming-powers as functions of the speed), by Lieut. Fournier. French Navy. Building of Government Vessels in Private Shipyards,—a memorandum on the payment of installments during the course of construction. A Vocabulary of Powders and Explosives (continued).

The Vol. contains a table of the matter published in the *Review* during the year 1893.

VOLUME CXX., JANUARY, 1894. A Few Correspondent and Circum-meridian Formulas of Navigation by Aid of the Condensed Tables.

The condensed tables are adapted to all circumstances of observation, and are especially so to the computation of night observations. As they contain, besides, abridged tables of logarithmic sines and cosines and common logarithms, they will be found convenient in the rapid computation of many formulas not requiring great approximation.

Relief and Assistance to the Wounded and Shipwrecked Sailors of Naval Wars. Determination of the Speed of Vessels from the "Wash,"—or the Waves it Produces.

RIVISTA DI ARTIGLIERIA E GENIO.

VOLUME I., JANUARY, 1894. About the Reorganization of the Austro-Hungarian Technical Corps. The Future of Small Fire-Arms. Field Pocket Telegoniometer.

RIVISTA MARITTIMA.

VOLUME I., JANUARY, 1894. Astronomical Notes. About Ships' Armors (ended). The Use of Search-Lights in Coast Defense. Cooper and Loti.

SUPPLEMENT TO RIVISTA MARITTIMA.

Project of an Italian Naval Bibliography.

SOCIÉTÉ DES INGÉNIEURS CIVILS.

NOVEMBER AND DECEMBER, 1893. A Note on Parabolic Junctions Applied to Railways in Actual Operation. Note on the Rigidity of Hempen Cables, Leather Straps, and on the Comparative Yield of Transmission Through Hempen Cables and Leather Straps. "Comptes Rendus" of the Society for the Advancement of National Industry. J. L.

STEAMSHIP.

VOLUME V., No. 55, JANUARY, 1894. Comparing and Estimating Steamship Performances.

Abstract of a paper by Mr. Hök, who reduces all vessels to a common standard of length, and compares their then powers, stated in terms of displacement, by diagrams, the speed of the model of unit length being used as a base scale.

Influence of Scientific Methods on Shipbuilding.

FEBRUARY. Screw-Propellers, Reversing Screw-Propellers, and Non-Reversible Engines.

Mr. Robt. McGlasson advocates non-reversible engines, thereby getting rid of much engine gear, and avoiding the severe stresses set up by reversing. By his method the reversal is done on the propeller blades, and by the same means an adjustment of pitch is obtainable. The gear may be worked from the bridge. The system has been successfully applied to small vessels, but the discussion developed an almost unanimous disbelief in the possibility of adopting it to large ships.

Pump Valves.

MARCH. Bronze *versus* Cast Iron for Propellers. Flying Machines. "Baird-Thompson" Improved System of Ship Ventilation. Pump Valves. Transport of Petroleum in Bulk. Engineers in the Royal Navy. H. S. K.

UNITED SERVICE GAZETTE.

No. 3183, JANUARY 6, 1894. Lord Brassey on Our Naval Strength. Naval: The Naval Record for the Past Year.

JANUARY 13. The New Naval Programme. The Problem of Mounted Infantry Solved by Cyclists. Naval. War-Ship Intelligence. Musketry Experimental Firing. The Health of the Navy, I. Correspondence: Naval Guns. The Advantage of High Velocity.

JANUARY 20. Imperial Defense. The Health of the Navy, II. Torpedo-Boat Destroyers.

JANUARY 27. The Evolution of the Torpedo, I. Imperial Defense and the Navy. The Value of the Ram.

FEBRUARY 3. The Maintenance of Our Naval Supremacy. The Wilderness Campaign of 1864.

FEBRUARY 17. The Stability of Iron-Clads. Navies of European Powers. Our Naval Deficiencies. J. H. G.

LE YACHT.

No. 822, DECEMBER 9. The Navy. The Dupuy-de-Lôme. The Fox Fire-Box. Foreign Navies: England, Italy and the United States.

DECEMBER 16. Increase of the English Naval Establishment. The Aluminium Yacht Vendenesse.

DECEMBER 23. "The French Navy," a book by Maurice Loir. Union of French Yachts. Admission. Concession of Flags.

DECEMBER 30. Trials of Harveyized Plates. Chronicles of the English Races. English Constructions During the Year 1893.

JANUARY 6, 1894. The Navies of the World in 1893. The Question of Gauge Formula apropos of the Yacht Gyptis. The Jules Davoust—an Aluminium Boat. Use of Soluble Cases in Oceanographic Measurements and Experiments. The Thoulet Case.

JANUARY 13. Government Dock-Yards and Constructions the 1st of January, 1894. Origin of the Centre Board.

JANUARY 20. Criticisms of the Navy. The Explosion on board the Torpedo-Boat Sarrasin. On the Position and Form of Rudders for the Turning Manœuvre of Steam Vessels.

JANUARY 27. The Navy Investigation. The Extra Premium to Merchant Vessels. Launching of the Cruisers Chanzy and Linois.

FEBRUARY 3. The Navy Investigation (E. Weyl). Sea-going Torpedo-Boat Lansquenet. Technical Review of the Chicago Exposition.

FEBRUARY 10. The Navy Interpellation (E. Weyl), Naval Technic Association. Sailing Conditions of Slow-Speed Vessels.

J. L.

REVIEWERS AND TRANSLATORS.

Lieutenant HUGO OSTERHAUS, U. S. N. Lieutenant H. S. KNAPP, U. S. N.
" J. H. GLENNON, " Ensign R. D. TISDALE, "
Professor JULES LEROUX.

OFFICERS OF THE INSTITUTE,

1894.

Elected at the regular annual meeting, held at Annapolis, Md., October 18, 1893.

President.

REAR-ADMIRAL S. B. LUCE, U. S. N.

Vice-President.

COMMANDER C. M. CHESTER, U. S. N.

Secretary and Treasurer.

LIEUTENANT H. S. KNAPP,* U. S. N.

Board of Control.

LIEUT.-COMMANDER B. F. TILLEY, U. S. N.
LIEUT.-COMMANDER R. R. INGERSOLL, U. S. N.
LIEUTENANT G. L. DYER, U. S. N.
LIEUTENANT HUGO OSTERHAUS, U. S. N.
PASSED ASST. ENGINEER W. F. WORTHINGTON, U. S. N.
PROFESSOR N. M. TERRY, A. M., PH. D.
LIEUTENANT H. S. KNAPP,* U. S. N. (*ex-officio*).

* Resigned. Lieut. J. H. Glennon, U. S. N., was elected by the Board of Control to fill the vacancy, December 12, 1893.

ANNUAL REPORT OF SECRETARY AND TREASURER OF THE U. S. NAVAL INSTITUTE.

TO THE OFFICERS AND MEMBERS OF THE INSTITUTE:

Gentlemen:—I have the honor to submit the following report for the year ending December 31, 1893.

ITEMIZED CASH STATEMENT.

RECEIPTS DURING YEAR 1893.

Items.	First Quarter.	Second Quarter.	Third Quarter.	Fourth Quarter.	Totals.
Dues	$1080 00	$525 60	$336 00	$179 75	$2121 35
Subscriptions	240 35	244 55	186 75	192 67	864 32
Advertisements	168 75	223 74	20 00	49 37	461 86
Interest	72 92	18 00	65 50	28 99	185 41
Sales	203 43	51 19	22 13	63 20	339 95
Binding	19 50	14 27	6 95	..	40 72
Credits on account	1 18	2 72	16	..	4 06
Repayment protested check	3 00	..	..	..	3 00
Exchange	..	34 59	..	..	34 59
Premium on foreign check	..	01	..	..	01
Life membership fee	..	..	30 00	..	30 00
Return over-payment of salary	..	..	5 00	..	5 00
Totals	$1789 13	$1114 67	$672 49	$513 98	$4090 27

EXPENDITURES DURING YEAR 1893.

Items.	First Quarter.	Second Quarter.	Third Quarter.	Fourth Quarter.	Totals.
Printing publications	$368 05	$621 80	$388 90	$125 22	$1503 97
Salaries	240 00	240 00	245 00	246 13	971 13
Postage	37 44	25 06	22 72	21 91	107 13
Expressage, freight and hauling	15 84	2 95	6 12	11 24	36 15
Binding	35 87	2 00	1 00	3 20	42 07
Office expenses	8 94	48	2 55	3 58	15 55
Telegraphing, messengers, etc.	1 21	50	76	..	2 47
Expenses, business trips	1 50	75	3 02	..	5 27
Expenses Washington Branch	72	26	..	..	98
Purchase of back numbers	4 50	..	..	..	4 50
Stationery	36 32	..	49 38	..	85 70
Advertising Agent's commission	3 25	..	..	..	3 25

EXPENDITURES—*continued.*

Items.	First Quarter.	Second Quarter.	Third Quarter.	Fourth Quarter.	Totals.
Half profits of sale of No. 34	$11 85	..	..	..	$11 85
Expense on article	12 00	..	..	..	12 00
Repayment protested check	3 00	..	..	..	3 00
Return dues, deceased member.	2 00	.	..	..	2 00
Exchange	..	34 59	..	..	34 59
Transfer from credit	..	46	..	..	46
Typewriting and draughting	..	..	5 00	..	5 00
Custom-house fees	..	..	1 50	..	1 50
Discount on foreign remittance.	..	..	01	..	01
Subscription Navy and Marine Corps directory	..	..	..	5 00	5 00
Totals	$782 49	$928 85	$725 96	$416 28	$2853 58

SUMMARY.

Balance of cash unexpended for the year 1892	$3979 70
Total receipts for 1893	4090 27
Total available cash, 1893	$8069 97
Total expenditures for 1893	2853 58
Cash unexpended January 1, 1894	$5216 39
Cash held to credit of reserve fund	72 89
True balance on hand January 1, 1894	$5143 50
Bills receivable for dues 1893	549 00
" " " back dues	723 80
" " " binding	14 10
" " " subscriptions	15 00
" " " sales	10 55
" " " advertisements	12 50
Value of back numbers (estimated)	2000 00
" " Institute property	100 00
Total assets	$8568 45

The liabilities of the Institute consisted on January 1st of the bill for printing whole No. 68, which had not been delivered on that date.

RESERVE FUND.

United States 4 per cent consols, registered	$900 00
District of Columbia 3.65 per cent registered bonds	2000 00
" " " 3.65 " coupon bonds	450 00
	$3350 00
Cash in bank uninvested	72 89
Total Reserve Fund	$3422 89
Number of new life members	1

Membership.

The membership of the Institute to date, January 1, 1894, is as follows: Honorary members, 6; life members, 106; regular members, 556; associate members, 195; total number of members, 863.

During the year 1893 the Institute lost 31 members by resignation, 11 by death and 1 dropped; 55 new members' names were added to the rolls—40 regular, 13 associate, and 1 associate member became a life member.

Members Deceased since January 1, 1893.

Regular Members.

Bassett, F. S., Lieutenant, U. S. Navy, October 19, 1893.
Batcheller, O. A., Commander, U. S. Navy, October 30, 1893.
Conway, W. P., Lieutenant, U. S. Navy, September 14, 1893.
Jenkins, T. A., Rear-Admiral, U. S. Navy, August 9, 1893.
Nelson, H. C., Medical Director, U. S. Navy, March 10, 1893.
Rhoades, W. W., Commander, U. S. Navy, September 30, 1893.
Vansant, W. N., Asst. Naval Constructor, U. S. Navy, January 1, 1893.
Wilson, Byron, Captain, U. S. Navy, September 6, 1893.
Waring, H. S., Lieutenant, U. S. Navy, November 4, 1893.

Associate Members.

Barr, Frank, Captain, U. S. Revenue Marine, September, 1893.
Harvey, H. A., Esq., August 28, 1893.

Publications on Hand.

The Institute had on hand at the end of the year the following copies of back numbers of its Proceedings:

	Plain.	Bound.		Plain.	Bound.
Whole No. 1	106	..	Whole No. 11	215	1
2	240	..	12	54	1
3	61	..	13	1	..
4	146	..	14	3	..
5	119	..	15	..	..
6	..	..	16	224	1
7	6	..	17	..	..
8	34	1	18	105	1
9	38	1	19	104	1
10	4	..	20	121	1

Whole No.	Plain.	Bound.
21	226	1
22	269	1
23	178	1
24	187	1
25	1141	44
26	210	80
27	301	27
28	5	16
29	210	9
30	246	4
31	42	56
32	18	173
33	10	162
34	12	..
35	140	5
36	268	29
37	192	24
38	231	1
39	22	1
40	25	115
41	253	19
42	106	19
43	156	3
44	52	10
45	39	19
46	43	19
47	24	19
48	47	18
49	17	17
50	56	17
51	31	18
52	54	16
53	147	34
54	6	7
55	57	17
56	538	55
57	18	20
58	..	5
59	7	10
60	..	1
61	181	18
62	193	16
63	330	8
64	33	19
65	129	18
66	8	18
67	6	18

8 No. 34, bound in half calf.
1 Vol. X., Part 1, bound in half morocco.

Very respectfully,

J. H. GLENNON, *Lieut., U. S. Navy,*
Secretary and Treasurer.

ANNAPOLIS, MD., *January 1, 1894.*

SPECIAL NOTICE.

NAVAL INSTITUTE PRIZE ESSAY, 1895.

A prize of one hundred dollars, with a gold medal, is offered by the Naval Institute for the best essay presented on any subject pertaining to the naval profession, subject to the following rules:

1. The award for the prize shall be made by the Board of Control, voting by ballot and without knowledge of the names of the competitors.

2. Each competitor to send his essay in a sealed envelope to the Secretary and Treasurer on or before January 1, 1895. The name of the writer shall not be given in this envelope, but instead thereof a motto. Accompanying the essay a separate sealed envelope will be sent to the Secretary and Treasurer, with the motto on the outside and writer's name and motto inside. This envelope is not to be opened until after the decision of the Board.

3. The successful essay to be published in the Proceedings of the Institute; and the essays of other competitors, receiving honorable mention, to be published also, at the discretion of the Board of Control; and no change shall be made in the text of any competitive essay, published in the Proceedings of the Institute, after it leaves the hands of the Board.

4. Any essay not having received honorable mention, may be published also, at the discretion of the Board of Control, but only with the consent of the author.

5. The essay is limited to fifty (50) printed pages of the Proceedings of the Institute.

6. All essays submitted must be either type-written or copied in a clear and legible hand.

7. The successful competitor will be made a Life Member of the Institute.

8. In the event of the Prize being awarded to the winner of a previous year, a gold clasp, suitably engraved, will be given in lieu of a gold medal.

By direction of Board of Control.

J. H. GLENNON,

Lieut., U. S. N., Secretary and Treasurer.

ANNAPOLIS, MD., *January* 3, 1894.

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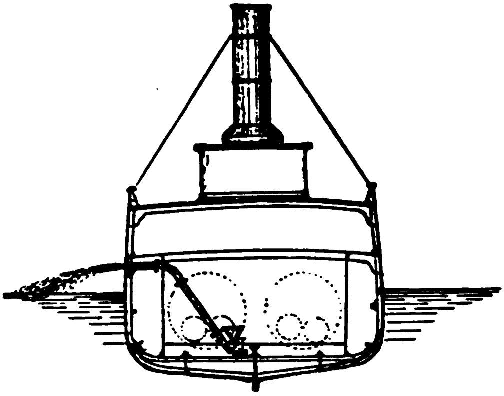

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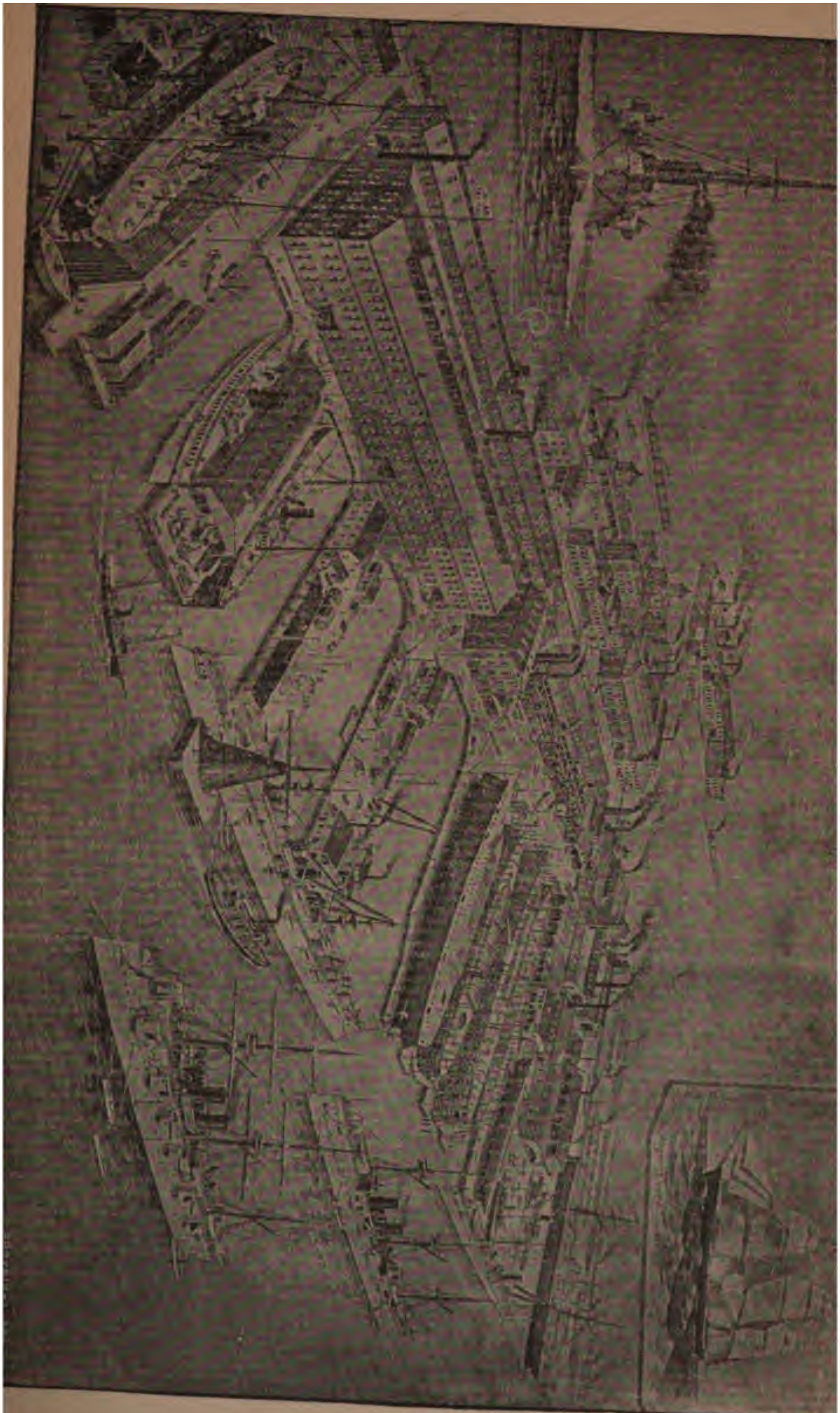

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